ASSESSMENT OF NONPOINT SOURCE POLLUTION IN TRIBUTARIES TO THE GREAT BAY ESTUARY

FINAL REPORT

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by

Stephen H. Jones and Richard Langan

Jackson Estuarine Laboratory

University of New Hampshire

FINAL REPORT FOR NONPOINT SOURCE POLLUTION TRIBUTARY SAMPLING

INTRODUCTION

In August of 1993, a project was initiated to monitor water quality conditions in both freshwater and tidal portions of the tributaries of the Great Bay Estuary. The purpose of the project was to gather broad scope information on spatial and temporal aspects of NPS pollution in the watershed, and to determine the effects of storm events on the levels of surface water contamination. The project was a cooperative effort between the NH Dept. of Environmental Services, NH Div. of Public Health Services, NH Fish and Game Dept., Jackson Estuarine Laboratory (UNH) and the NH Office of State Planning.

METHODS

Thirteen sites in the Great Bay watershed in addition to a site at the Hampton Harbor Inlet, area were sampled and analyzed following eight rain events by JEL personnel, and eight times under a random (meteorological) sampling protocol (NSSP) by DES, OSP and DPHS personnel (Figure 1). The sites consisted of one freshwater and one tidal site each in the Cocheco, Bellamy, Salmon Falls, Lamprey, Exeter-Squamscott and Oyster Rivers, with additional tidal sites in the lower Piscataqua River and the Hampton Harbor Inlet. Each month, a sample from a freshwater site and a tidal site sample were split for comparative nutrient and microbial analyses by the JEL and State laboratories. The criterion used for defining a storm sampling date was > 0.25 " of rain prior to sampling on the sample date and during the previous day.

Measurements of temperature, salinity, dissolved oxygen, pH and observations of weather conditions were recorded at the sampling times. Separate containers were used for collection of water samples for microbial and suspended solids/nutrient analyses. Storm sample collection and processing methods were conducted according to JEL SOP's 1.05 and 1.06. Nutrient analyses for JEL samples were done using Lachat Method 11-107-06-1-C for ammonium, method 30-107-04-1-A for nitrite/nitrate and the wet chemistry method of Parsons et al (1981) for orthophosphate. Microbial analysis of JEL samples involved standard membrane filtration methods using mTEC agar for detection of fecal coliforms and *Escherichia coli* and mE agar for detection of enterococci.

RESULTS

Nutrients and physical parameters

Since nutrient analyses were performed by different laboratories for the storm samples and randomly collected samples, sample splits were used to compare results generated by the DES and JEL analytical laboratories. Results of the split sample analyses are presented in Tables 1 through 3. Regressions of the results from the two laboratories as well as scatter plots of JEL data vs. DES data are included in these tables. The best R^2 value was obtained for NO3 (.91) (Table 2) , followed by NH4 (.78) (Table 1) and PO4 (.58) (Table 3). The primary differences in results for the nitrogen species were associated with the lower concentrations, probably due to the high detection limits (6.3 μM NH, 1.4 μM NO3) in the LACHAT methods used by DES. There was poor agreement in results for the PO4 methods, at both the high and low end. Though split samples were not run for suspended solids, the DES data, particularly the estuarine sites, were consistently higher than the JEL data. Nevertheless, the data were analyzed as (1) a combined data set; (2) random sampling compared to storm sampling; (3) random samples that were collected within 24 hours of substantial rainfall (11/2/93, 5/17/94 and 6/14) were combined with storm sampling and compared as "wet" samples to the remaining random or "dry" samples. Storm samples which were found to violate the criteria for "wet" conditions (5/3/94 and 6/22/94) were included in the "dry" data.

Combined nutrient and suspended solids data from the random sampling and storm sampling are presented in Table 4. Figures 1A-4 illustrate the site means for all samples for the ten month period. For ammonium, the highest concentrations were observed in the freshwater and estuarine site in the Cocheco and Salmon Falls rivers, the estuarine site in the Squamscott River, and the freshwater site in the Oyster River (Fig. 1A). The highest nitrate concentrations were measured in the freshwater sites in the Cocheco and Salmon Falls rivers, with the estuarine sites in the same two rivers also showing high concentrations. The tidal site in the Squamscott River and the freshwater site in the Oyster River also had elevated NO3 by comparison to other sites (Fig. 2). With the exception of the Salmon Falls and Cocheco rivers, PO4 levels were generally low at the freshwater sites, and elevated in the estuarine sites in the Cocheco, Lamprey, Squamscott and Oyster rivers (Fig. 3). Total suspended solids were consistently lower in the freshwater sites of each river. Highest concentrations were measured in the Squamscott tidal site, followed by the Lamprey River, Oyster River and Hampton Harbor (Fig 4).

Storm sampling data (Table 5) were analyzed independently from the random

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samples, and station means are presented in Figures 5 through 11. The highest ammonium concentrations were measured in the freshwater site in the Salmon Falls River. Both Cocheco River sites, the tidal sites in the Salmon Falls, Squamscott and Oyster rivers, and the freshwater site in the Oyster River also showed elevated ammonium concentrations (Fig. 5). The freshwater sites in the Salmon Falls and Cocheco also had the highest concentrations of nitrate, followed by their tidal counterparts and the tidal Squamscott and freshwater Oyster river sites (Fig. 6). As was the case with the combined data analysis, PO4 concentrations were generally lower in the freshwater sites with the exception of the Salmon Falls and Cocheco rivers. The highest PO4 concentrations were found in the tidal portions of the Squamscott, Oyster and Lamprey rivers (Fig. 7). Suspended solids following storms were all quite low in the freshwater sites, and with the exception of the Squamscott and Lamprey river tidal sites, quite low at the tidal sites as well (Fig. 8). Percent organic content was high (45-67%) at the freshwater sites with low suspended solids concentrations, and from 17-32 % at the tidal sites with higher solids concentrations (Fig. 9). Mean salinities following rain storms for the tidal sites are shown in Fig. 10. The highest salinities were measured in the lower Piscataqua, Bellamy and Oyster River mouths, and the inlet to Hampton Harbor. Similar salinities were measured in the Salmon Falls, Cocheco, Squamscott and Lamprey Rivers (Fig. 10). Mean pH for the freshwater sites (7.1-7.3), and tidal sites (7.6-7.9) were similar (Fig 11).

Nutrient and suspended solid data from the random sampling are presented in Table 6, and comparisons of the sample site means for storm samples and random samples are shown in Figures 12 through 15. For most sites, the same pattern of ammonium concentrations (in terms of which stations had the greatest mean concentration of ammonium) was observed for random and storm samples, with storm samples generally higher. The exceptions to this pattern were for sites with storm sample means lower than the DES detection limit (Fig. 12). The station means for nitrate concentrations were very similar for the sites with higher concentrations, and higher in the random samples at sites with lower concentrations (Fig 13). Storm sample concentrations of PO4 were higher than the random samples for all the freshwater sites and the tidal sites in the Cocheco, Salmon Falls, Oyster and Piscataqua Rivers. Mean storm PO4 concentrations were lower than the random sample means in the Bellamy, Lamprey, and Squamscott rivers and Hampton Harbor tidal sites (Fig. 14). Mean TSS concentrations in both storm and random samples were similarly low for all the freshwater sites, and with the exception of the tidal Squamscott River site, much higher in the random samples than the storm samples (Fig. 15).

In examining actual rainfall amounts for the sampling dates (Table 6A), three of the random sample dates fit the rainfall criteria for storm sampling (11/2/93,

5/17/93 and 6/14/93), while two of "storm sample" dates did not meet the criteria (5/3/94 and 6/22/94). In order to obtain a more accurate picture of potential differences in contaminant conditions between sampling dates that followed rain events and those conducted during a dry period, the "wet" samples from the random data set were added to the storm sample data set, and the "dry" storm samples were added to the random data set, thus creating a more accurate assessment of wet and dry conditions. Sample site means were calculated for the nutrients and suspended solids for the two conditions. Comparisons are presented in Figures 16 through 19. Rearranging the ammonium data in this way did not change the relationship that was observed for the storm-random data (Figs 12 and 16). The changes observed for mean NO3 concentration , however, were that NO3 was higher in the "dry" samples at the freshwater sites in the Cocheco and Salmon Falls rivers, and higher in the "wet" samples at the tidal Squamscott River site. Otherwise, the site comparisons did not change with the data transformation (Figs. 13 and 17). Site means for PO4 concentration and TSS concentration in the "dry"-"wet" comparisons were no different than the storm-random comparisons (Figs. 14 and 18, Figs. 15 and 19).

Individual sampling dates for all the nutrient and suspended solids data combined were plotted to see if there were any obvious temporal trends. This type of analysis would not be definitive because of the sampling gap between December and April. For each plot (Figures 20-31) a single parameter (ie. NH4) at freshwater and corresponding tidal sites for two tributaries were plotted vs time. The two tidal only sites (GB 13 and HH 1A) were plotted together. For ammonium at the Cocheco and Salmon Falls river sites, the highest concentrations were measured in the fall, though the concentrations in the freshwater portion of the Salmon Falls River appear to be independent of season (Fig. 20). No temporal trend was observed for ammonium concentration in the Bellamy and Lamprey Rivers, though the November-December concentrations seemed lower that expected (Fig 21). In the Exeter-Squamscott and Oyster Rivers, a single very high ammonium concentration was observed in the freshwater portion of the Oyster River in December. Otherwise, the only observable temporal trend was that concentrations were lowest in April-May (Fig. 22), probably coincident with the spring phytoplankton bloom. No ammonium concentration trend was obvious from the Piscataqua River and Hampton Harbor data, other than that the two sites appeared to have similar variation, and lowest concentrations were observed in the late fall and early spring (Fig. 23). Nitrate levels throughout the year were consistently higher in the freshwater sites in the Cocheco and Salmon Falls Rivers, and concentrations at all sites, both tidal and fresh, were lowest in early spring, and highest in freshwater sites in the early fall (Fig. 24). Nitrate concentration in the Bellamy and Lamprey Rivers

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was highest in the late fall and winter, and highest at that time in the freshwater portions of those rivers. Lowest concentrations were observed at all sites in the spring (Fig. 25). A similar temporal trend was observed in the Exeter-Squamscott and Oyster rivers, though the highest nitrate concentrations were measured in the tidal Squamscott River and freshwater Oyster River sites in the fall (Fig. 26). At the Hampton and Piscataqua River sites, the highest nitrate concentrations were measured in fall and winter, and the lowest in spring (Fig. 27). A single high phosphate concentration measured in the tidal Cocheco River sample in early September was the exception to the high late fall-low spring trend in the Cocheco and Salmon Falls Rivers. The freshwater Cocheco River site was higher for most sample dates than the others (Fig. 28). PO4 concentrations in the freshwater sites in the Bellamy and the Lamprey rivers were lowest in the summer and early fall, increased in the winter months, and decreased again in the early spring. This trend was not as clear cut for the tidal sites in the Bellamy and the Lamprey rivers, and concentrations were also quite a bit higher in the fall and winter (Fig. 29). The Exeter-Squamscott River and Oyster River PO4 concentrations were very similar, both for temporal trends and freshwater-tidal differences, to the Bellamy and Lamprey Rivers (Figs. 29 and 30). In the Hampton and Piscataqua River samples, the only noticeable temporal trend was that the early spring samples had the lowest PO4 concentrations.

Bacterial Indicators

The same approach for data analysis given the nutrient data was applied to the bacteriological data. The data for fecal coliforms, *E. coli* and enterococci concentrations from split samples are presented in Table 7. Geometric means for analyses from the two labs showed relatively good agreement. Generally, higher fecal coliform and *E. coli* levels were detected in the freshwater sites and lower levels in tidal sites at both labs. For enterococci, the State numbers were higher for freshwater compared to tidal sites, while little difference was observed for JEL analyses. Thus, the overall mean for State enterococci levels is higher than that for JEL data.

Because *E. coli* is one of numerous bacterial species that constitute fecal coliforms, their levels should be lower than fecal coliform levels. This was the case for JEL analyses, but the fecal coliform levels for the State analysis were consistently lower than *E. coli* levels. This was a function of DES using mFC medium for detecting fecal coliforms and mTEC medium for *E. coli*, while JEL used mTEC for both. The mTEC method could be expected to give higher detectable colonies because it involves a 2-step temperature incubation designed to better detect injured

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bacteria, and it also uses a smaller pore size (0.45 μM) filter compared to the mFC method (0.7 μm). Thus, the mTEC method could be expected to detect more injured and smaller cells compared to the mFC method. In many instances in the following presentation of bacterial results, the State fecal coliform concentrations are presented as 'modified' data. For this modification, fecal coliform levels that were less than reported *E. coli* levels were considered to be equal to *E. coli* levels.

The split sample results are analyzed separately for each indicator in Tables 8-10. Comparison of JEL fecal coliform data to raw State data gave an r2 value of 0.45, indicative of a poor direct relationship between results of analyses from the same sample (Table 8). After modifying the State data as previously described, an excellent relationship was indicated between labs, with an r^2 value of 0.97 for all data. Inspection of specific pairs of numbers shows a consistent trend for each pair, with high or low JEL numbers corresponding to the same for State data. A strong direct relationship for analyses from the two labs is expected, and modification of the State data for better intepretation of results appears to be justifiable from this regression analysis. A similar strong direct relationship between State and JEL *E. coli* analyses is presented in Table 9. The results for the two indicators are expected to be similar because of the similarity in methods. The enterococci splits did not agree as well. Generally, high or low JEL data were also high or low for corresponding State data, although the State numbers were often higher than corresponding JEL numbers (Table 10). However, there were a few instances where paired data were different by a large degree. Of particular concern are two pairs where one lab reported its highest level and the other lab reported a much smaller level. As shown in the graph, these opposing, highly variable results can ruin the overall relationship between the two sets of data, as reflected in the r2 value (0.36). These differences could be a function of variability within a split sample if the splitting or initial sampling procedure is faulty. More likely, differences in analytical methods or sample handling procedures between labs could cause observed differences.

Data for the JEL storm sampling are presented in Table 11, and data for the State random sampling are presented in Table 12. Geometric averages of the three indicators for data combined are summarized in Table 13, and the geometric means for the combined data from the different sites are illustrated in Figures 32-34. Results with raw and modified State data are presented in Figures 32 and 32A, respectively, with the only difference being higher overall levels in Figure 32A compared to Figure 32. The data show high overall levels at the freshwater sites in the Oyster River, Exeter River, and especially the Cocheco River. These areas are the most urbanized of the freshwater sites. Other freshwater and tidal sites had relatively low levels, except for the tidal site in the Lamprey River, which is much more influenced by urban Newmarket compared to the freshwater site. High fecal

coliform levels at this site have been observed consistently for a number of years, and independent efforts are being made to identify sources. As expected, the same trend was observed for *E. coli* results (Figure 33). Overall enterococci levels were not as high as for fecal coliforms and *E. coli*, so differences between sites were not as pronounced. The four sites with the highest levels were the same four as with fecal coliforms, but the highest levels were observed at the Oyster River freshwater site, with the freshwater Cocheco River site next highest.

On two dates, the State also sampled upstream from the freshwater sites in the Cocheco, Oyster and Exeter rivers to potentially bracket sources of contamination. Inspection of specific data for all three indicators at the different sites shows upstream sites in the Cocheco and Exeter rivers were more contaminated than the routine sites on 5/17, but not on 6/14. Levels of *E. coli* were slightly higher at the Oyster River upstream site on 6/14. In the Cocheco River, the furthest upstream site (22-CCH) had somewhat lower levels of indicators compared to the middle site (11-CCH), and more comparable to the routine site.

A major focus of this study was to see if contaminant levels are relatively higher following rainfall events at the different sites. The JEL sampling was designed to follow rainfall events, and the geometric means for these samples are summarized in Table 13 and illustrated in Figures 35-37. Storm sample means for fecal coliforms and *E. coli* are all higher than the means for the combined data, except for the tidal sites at the mouths of the Bellamy and Oyster rivers (Table 13). This suggests that rainfall increases contamination of the sites. The highest fecal coliform and *E. coli* levels were observed in the freshwater sites of the Oyster, Exeter, and Cocheco rivers, and the tidal site in the Lamprey River (Figures 35-36). In addition, levels in the tidal site of the Cocheco River were also relatively high, with *E. coli* levels higher than in the freshwater site. The same relationships between levels at freshwater compared to corresponding tidal sites as observed for the combined data are observed for the storm data, except for the tidal site storm data being higher than the freshwater sites in the Salmon Falls and Cocheco rivers for *E. coli* and for the fecal coliform data at the Salmon Falls River sites. Other sites with relatively high levels are the tidal site in the Salmon Falls River and the freshwater site in the Bellamy River. Enterococci levels from JEL data were not as high compared to the combined data as with the other two indicators (Table 13), reflecting the relatively higher levels reported by the State. Again, the highest sites were the same as with the combined data, with the two highest sites being the freshwater Oyster River site and the tidal Lamprey River site (Figure 36). The same relationships between levels at freshwater compared to corresponding tidal sites as observed for the combined data are observed for the storm data.

The geometric means from the random samples analyzed by the State are also

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presented in Table 13. These samples represent for the most part dry samples, and the geometric means are compared to JEL storm sample results in Figures 38-40. The two sets of data do not give similar spatial trends for different fecal coliform and *E. coli* levels, except that the freshwater site in the Cocheco River again had the highest levels (Figures 38-39). The sites with the next two highest levels were the tidal sites at the mouths of the Oyster and Bellamy rivers, sites that had the lowest levels for storm samples. For enterococci, the levels were again all relatively low, so differences among sites were minimal (Figure 40). The sites with the three highest means are the freshwater sites in the Cocheco and Oyster rivers, similar to storm samples, and the tidal site in the Oyster River. For all three indicators, levels at the tidal sites on the Salmon Falls, Cocheco and Lamprey rivers were all relatively low, whereas these sites had high levels of indicators following storm events. This suggest that these sites may be most affected by runoff-associated contamination.

A more accurate way of determining the effects of rainfall events is to compare results for samples collected according to the criteria upon which storm sampling was based. For this, rainfall data from the Durham station were used to determine if rainfall on the day of sampling and the previous day combined was >0.25 inches, in which case the sample date could be considered a storm, or 'wet' sampling date, and all other dates (<0.25 inches) are considered 'dry' dates. Storm and random data were reorganized to meet these criteria, and the geometric means for the different sites are summarized in Table 13. Comparisons of dry vs. wet concentrations for the three indicators are illustrated in Figures 41-43. For all three indicators at all sites, levels for all geometric means for wet samples were greater than the means for dry samples, although to varying extents. This analysis did not show higher dry-date levels for the two tidal sites in the Oyster and Bellamy rivers, as did the storm vs. random data analysis. The sites with the four highest means for wet samples are the freshwater sites in the Cocheco, Exeter, and Oyster rivers and the tidal site in the Lamprey River for all three indicators (Figures 41-43). The difference between wet and dry levels at these four sites was most striking for all three indicators, illustrating the apparent large influence of runoff on contaminant levels. Again, these sites are all directly influenced by densely populated urban areas, while the other tributaries, including the Bellamy, Salmon Falls, and (freshwater) Lamprey rivers are impacted by less densely-populated upstream areas.

Concentrations of the three bacterial indicators on individual dates were plotted chronologically to see if there were any apparent seasonal or other temporal trends. The data set is not extensive, with no sampling in July or January through March. For each graph (Figures 44-55), data for a single indicator at freshwater and tidal sites for two tributaries are plotted together. As expected, the highest levels were apparent during wet sampling dates for fecal coliforms (Figures 44-47). The

highest levels (>1000 FC/100 ml) were observed on wet dates during autumn (9/7, 9/27, 11/18) and late spring (6/13) for the freshwater sites in the Cocheco, Exeter and Oyster rivers (Figures 44 and 46) and the tidal sites in the Salmon Falls (Figure 44), Bellamy (Figure 45) and Piscataqua (Figure 47) rivers. These four dates had four of the five rainiest periods prior to sampling of the nine wet dates, suggesting that amount of rainfall may have some direct relationship to level of contamination. Using modified data, fecal coliforms >1000/100 ml were also observed at the freshwater Cocheco River site on 8/24/93, a dry date. *E. coli* levels followed similar trends as observed for fecal coliforms (Figures 48-51). Generally, levels were highest on wet dates, with highest levels observed on three of the autumn dates and 6/13/94 at the same sites as for fecal coliforms. The trends for enterococci were not as distinctly related to wet/dry conditions (Figures 52-55). The highest levels (>250/100 ml) were observed at a number of sites on 9/27, 11/18 and 12/6, the top three rainiest dates, and 11/2, another wet sample date. The levels were consistently low for all sites on 12/20, 4/19 and 5/3, all dry dates sampled by the State (Figures 52-55).

DISCUSSION AND INTERPRETATION

Nutrients

The data gathered for this project provide a broad scope assessment of the spatial distribution of potential sources of nutrients in the Great Bay watershed. Both the random and storm sampling data indicate that certain tributaries are contributing greater amounts of dissolved inorganic nitrogen and phosphorus than others. The problem areas for ammonium are the fresh and tidal portions of the Cocheco and Salmon Falls rivers (particularly the freshwater Salmon Falls site), the tidal portion of the Squamscott River, and both fresh and tidal portions of the Oyster River. The freshwater portions of the Cocheco and Salmon Falls rivers by far had the highest nitrate concentrations, with the tidal portions of these rivers and the freshwater Oyster and tidal Squamscott rivers also showing elevated levels. Elevated phosphate levels were observed in the freshwater and tidal Cocheco samples, and the tidal Lamprey, Oyster and Squamscott samples. Suspended solids were the highest in the tidal Squamscott River samples, and very low in the freshwater samples. The other tidal sites were all higher than their freshwater counterparts, indicating either that there are sources of suspended sediments to the tidal areas or that resuspension is occurring.

Comparison of storm sampling data with random data and the "wet" vs "dry" data, indicates that some sites had elevated ammonium concentrations following

storm events. The sites with lower concentrations, however, did not appear to increase following rain events. Very little difference in mean nitrate concentration was observed between storm and non-storm samples and differences in PO4 levels were inconsistent. The observed inconsistencies in the storm/non-storm nutrient comparisons may be the result of the different analytical methods used by the two laboratories, particularly in the case of ammonium. This problem with detection limits may be solved in the next phase of the project as one laboratory will be conducting all the nutrient analyses. Salinity and pH measurements taken during the storm sampling indicate that the greatest freshwater influence in the estuarine system is from the Cocheco, Salmon Falls, Lamprey and Squamscott rivers, which are the same rivers in which high nutrient concentrations were measured. This suggests that nutrients may be entering the estuary from freshwater sources, although not necessarily in association with rainfall events.

Bacterial Indicators

The results of this study allow for an assessment of relative bacterial contamination entering the waters of the Great Bay Estuary from its major tributaries based on synoptic sampling during wet and dry periods. The tributary sites with the highest levels of contaminants were in the freshwater portions of the Cocheco, Oyster and Exeter rivers and the tidal portion of the Lamprey River. All of these sites are surrounded by and are dominated upstream by densely populated urban areas, in contrast to the less-densely populated areas surrounding the other tributaries (Bellamy, Salmon Falls, upstream Lamprey rivers). This suggests that either runoff, direct sources, or high densities of either on-site private sewage disposal sites or leaky municipal system pipes are contaminating these tributaries and eventually the estuary. The tidal site in the Lamprey River has been under investigation to locate contamination sources. Results from another study consistently show that the contaminants have a major impact on the water quality of Great Bay at the mouth of the river.

The effect of rainfall and associated runoff appears to intensify the nonpoint source contamination problem. In fact, except for the tidal portion of the Cocheco River, levels of bacterial indicators were relatively low at tidal sites for the other tributaries during dry periods compared to wet periods. The strong response to rainfall events, especially at the more urban areas, suggests that the downstream quality of estuarine water is most susceptible to degradation by these events. This was especially true during autumn when the heaviest rainfall events were sampled. Rainstorms recorded at the

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Durham station are typically heaviest and most frequent during the autumn season (data not shown). A better understanding of sources and the influence of rainfall/runoff events is needed, and should become more clearly defined with a continuation of this study.

One of the most critical issues that is affected by nonpoint source microbial contamination is the harvesting of shellfish. There are abundant oyster resources throughout the Great Bay Estuary, although only some areas in Great and Little bays are currently classified as approved in New Hampshire. However, the Maine side of the Piscataqua River is classified as restricted, and it is an active site for commercial shellfishing; the harvested oysters are purified before marketing, as required by law from restricted areas. The continued contamination of these areas by nonpoint source pollution is an issue that needs attention, as increased economic pressures bring greater attention to New Hampshire's untapped shellfish resources. Based on the results of this study, it appears that storm events and urban areas have a large influence on contamination in the tributaries, with only the tidal site in the Squamscott River and the mouth of Hampton Harbor meeting NSSP criteria (geometric mean = <14 FC/100 ml) for dry periods, with no sites meeting these criteria for wet periods (Table 13; modified data).

The splitting of a tidal and freshwater sample each month for analysis by both involved labs proved to be a useful and necessary exercise to undertake for this study. It is especially important for deciding how to interpret the results. For fecal coliforms, it appeared that the different analytical methods used by the State compared to *E. coli* analysis caused reported levels to be lower than expected. The exercise of modifying the data to increase some fecal coliform data to becoming equal to *E. coli* data was based on the fact that *E. coli* can only constitute a portion or potentially equal concentration relative to fecal coliforms. Because both labs used mTEC medium for *E. coli* analysis, use of mTEC *E. coli* data for fecal coliform data allowed for a consistency within data sets including data from both labs, giving a more accurate interpretation of results. The lack of consistent agreement between enterococci data from the two labs is not well understood at this time.

Overall Study

A number of points pertain to the overall study independent of either category of contaminants studied. First, the splitting of analysis between two labs presented problems in interpreting data for all parameters. This is probably the result of different analytical methods being conducted by the two

labs, although efforts may still be needed to standardize common methods. This would include sample processing and holding procedures, as it is obvious that more time before analysis is necessary for the State labs because of the distance between sampling sites and the State labs. The method of splitting samples should also ensure that no inter-sample variability is introduced at that time.

Another issue is storm sampling. By taking a single sample on the day following a storm event, it is always possible that sampling could miss the major contamination pulse. However, the consistent trend of higher bacterial levels after wet compared to dry periods suggest that at least part of a contaminant pulse was caught by the sampling that occurred. Other factors that can affect the contamination response following a rainfall event include seasonal influences (temperature, presence of snow, evapotranspiration, etc.), intensity and duration of storms, and conditions prior to events (dry vs. wet). It appeared that for bacterial contaminants, the heavier rainfall events caused relatively greater amounts of contamination to occur at some sites. In addition, the present approach to rainstorm sampling could be improved if more immediate knowledge of the amount of rainfall that has occurred could be made available. At present, JEL personnel prepare for sampling upon hearing of predicted events, then confirm that the sampled event met the preset criteria only at the beginning of the next month when data for the Durham station are published. This worked quite well, despite several false starts, although two of eight 'events' did not meet the criteria. Despite these concerns, it appears that some useful trends were apparent from this first year of study on the tributaries to Great Bay Estuary.

Table 1. Regression of NH4 concentration for split samples.

DES μm NH4	JEL μm NH4
6.30	1.84
6.30	1.14
6.30	4.82
16.80	18.72
6.30	10.82
14.00	15.90
7.00	11.97
6.30	5.94
6.30	3.53
14.00	16.23
6.30	0.38
14.70	21.30
6.30	6.25
7.00	5.60

Regression Statistics

Multiple R	0.881701893
R Square	0.777398228
Adjusted R Square	0.758848081
Standard Error	1.970582441
Observations	14

DES vs. JEL μm NH4
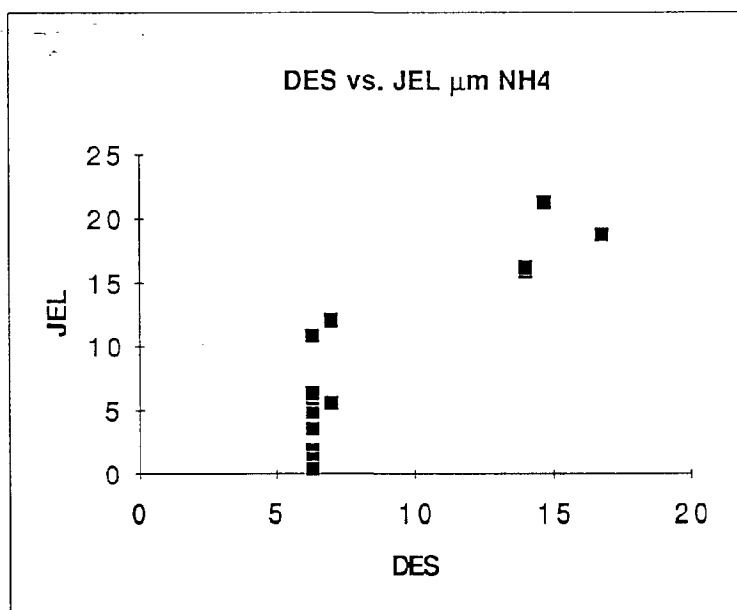
Table 2. Regression of NO3 concentration for split samples.

DES μm NO3	JEL μm NO3
8.4	5.13
1.26	3.63
13.3	6.27
25.2	35.12
4.2	8.02
4.2	5.99
9.8	4.42
60.9	65.51
39.9	39.27
54.6	43.61
11.9	6.38
9.1	5.82
11.2	13
39.2	50.3

Regression Statistics

Multiple R	0.954599147
R Square	0.911259531
Adjusted R Square	0.903864492
Standard Error	6.108090128
Observations	14

DES vs. JEL μm NO3
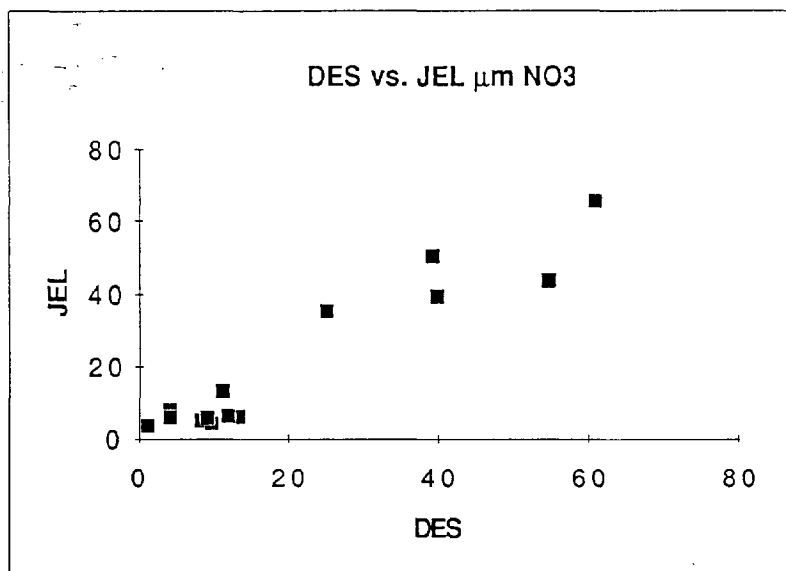
Table 3. Regression of PO4 concentration for split samples.

DES μm PO4	JEL μm PO4
1.271	1.6
1.736	2.22
2.046	2.14
1.054	1.41
2.139	1.29
0.217	0.43
0.93	0.94
0.558	0.78
0.031	0.45
1.395	2.24
1.891	1.06
0.372	0.52
0.558	0.92
1.209	1.43

Regression Statistics

Multiple R	0.75891422
R Square	0.575950794
Adjusted R Square	0.54061336
Standard Error	0.468213726
Observations	14

DES vs. JEL μm PO4
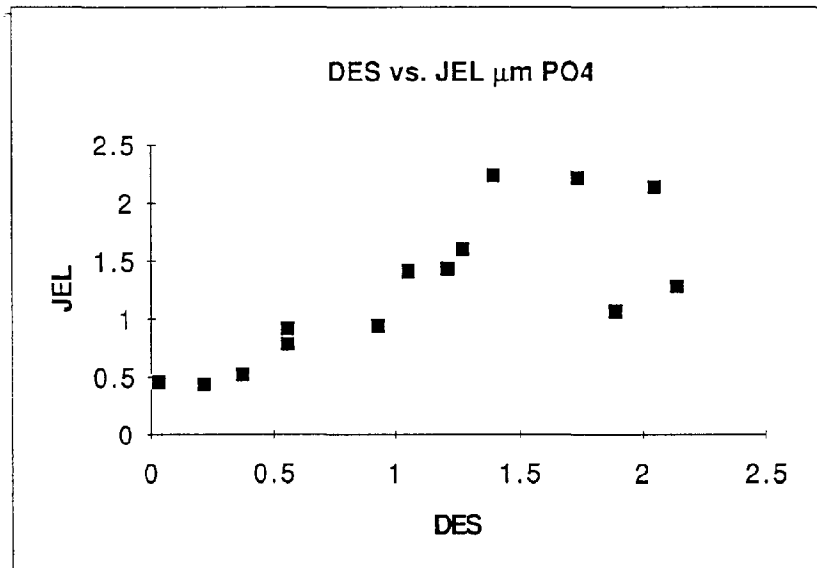
TABLE 4. ALL DATA COMBINED

DATE														
6/14/94	7.00	7.00	9.80	25.90	21.70	7.00	9.80		39.20	32.20	4.20	7.00	5.60	9.10
6/22/94	0.06	1.11	2.36	15.91	9.70	0.70	3.54	4.60	39.54	53.92	3.57	4.91	3.20	14.22
MEAN	5.07	5.24	6.18	14.31	11.40	5.68	10.12	4.35	32.68	39.79	6.10	5.10	5.33	11.34

PO4 CONCENTRATION μM

DATE	GB 2 um	GB 13 um	GB 15 um	GB 21 um	GB 22 um	GB 50 um	GB 80 um	HH 1A um	7 CCH um	5 SFR um	5 BLM um	5 LMP um	9 EXT um	5 OYS um
8/24/93	1.18	0.68	1.83	1.27	1.40	1.71	1.27	0.84	0.56	0.22	0.16	0.12	0.12	0.25
9/7/93	1.02	0.71	2.11	0.93	1.05	1.52	1.74	0.96	0.03	0.53	0.03	0.03	0.03	0.03
9/9/93	1.39	1.04	2.92	2.97	1.42	2.58	2.03	0.96	0.38	0.97	0.33	0.17	0.24	0.29
9/27/93	1.09	0.94	0.89	0.79	0.90	1.70	1.54	1.11	1.30	0.75	0.37	0.21	0.31	0.20
10/5/93	0.65	0.90	2.33	0.74	0.68	1.36	2.05	0.65	1.40	0.96	0.12	0.06	0.03	0.06
11/2/93	0.71	0.81	0.62	0.68	0.71	0.99	1.05	1.12	1.02	0.59	0.06	0.28	0.22	0.09
11/18/93	0.72	0.94	0.92	0.97	1.04	1.47	1.51	0.83	1.80	1.42	0.62	0.20	0.35	0.46
12/6/93	0.53	0.86	0.70	1.39	0.55	1.01	1.00	0.68	1.22	0.42	0.77	0.66	0.59	0.60
12/20/93	2.51	1.27	0.78	1.12	1.12	1.61	2.14		1.89	0.81	1.30	0.78	0.99	1.05
4/19/94	0.06	0.56	0.12	0.25	0.31	0.22			0.90	0.37	0.03	0.19	0.03	0.06
5/3/94	0.23	0.31	0.22	0.50	0.39	0.47	0.90	0.54	0.72	0.23	0.24	0.17	0.32	0.28
5/17/94	0.34	0.37	0.22	0.43	0.40	0.68			0.56	0.22	0.03	0.03	0.12	0.03
5/26/94	0.55	0.59	0.62	0.63	0.62	0.83	1.30	0.58	1.02	0.58	0.39	0.38	0.45	0.45
6/13/94	0.66	0.79	1.14	1.04	0.95	1.07	0.97	0.59	1.47	1.18	0.32	0.37	0.41	0.27
6/14/94	0.71	0.65	0.84	0.62	0.81	0.99	0.93		1.21	0.74	0.31	0.28	0.12	0.19
6/22/94	0.78	0.77	1.04	0.93	0.96	1.22	1.07	0.72	1.38	1.11	0.72	0.48	0.63	0.54
Mean	0.82	0.76	1.08	0.95	0.83	1.21	1.39	0.80	1.05	0.69	0.36	0.28	0.31	0.30

TSS mg/liter

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/93	8.00	6.00	24.50	20.50	19.00	40.00	41.50	11.00	7.00	9.00	1.50	0.09	1.50	2.50
9/7/93	25.00	5.00	6.00	11.00	13.50	8.00	8.50	11.00	7.00	1.00	5.50	3.00	4.00	1.00
9/9/93	3.80	0.40	3.20	12.80	1.60	2.20	7.80	2.80	7.20	0.60	3.40	0.20	0.80	1.20
9/27/93	1.60	1.40	18.60	1.60	2.40	3.40	30.60	3.00	5.00	3.00	2.60	1.20	3.40	2.40
10/5/93	51.00	55.00	37.00	30.00	36.00	52.00	57.00	57.00	3.00	3.00	5.00	5.00	3.00	6.00
11/2/93	14.00	3.00	43.00	19.00	87.00	70.00	36.00	56.00	1.00	3.00	1.00	0.90	2.00	0.09
11/18/93	6.00	3.20	10.00	5.80	4.00	5.40	31.00	9.80	4.60	0.80	7.80	1.00	3.00	9.00
12/6/93	3.40	13.20	24.60	8.40	4.80	5.00	28.20	6.80	7.60	1.20	4.00	7.80	5.00	9.20

TABLE 4. ALL DATA COMBINED

4/19/94	3.00	1.00	12.00	3.00	1.00	4.00			2.00	0.90	1.00	0.90	1.00	1.00
5/3/94	6.20	12.20	2.00	7.40	6.20	10.80	37.00	13.60	4.40	3.20	2.00	0.60	1.80	5.40
5/17/94	5.50	2.50	12.50	6.00	7.00	5.50			4.00	4.00	2.00	1.00	2.00	4.50
5/26/94	6.80	4.80	18.40	6.80	7.80	6.60	106.67	11.40	2.20	2.00	2.00	0.80	1.00	3.40
6/13/94	5.40	3.80	9.60	7.00	7.60	5.80	40.00	2.60	3.00	4.40	2.20	3.40	2.00	8.80
6/14/94	5.50	2.00	7.00	5.50	3.50	4.50	35.00		2.00	3.00	2.00	3.00	2.00	9.00
6/22/94	6.20	6.40	32.20	5.80	5.80	6.40	19.80	3.60	3.20	3.60	2.80	1.20	1.20	4.20
12/20/94	5.00	6.50	19.00	5.00	6.00	5.00	17.00		4.80	4.40	3.20	4.00	4.50	4.00
Mean	9.78	7.90	17.48	9.73	13.33	14.66	35.43	15.72	4.25	2.94	3.00	2.13	2.39	4.48

TABLE 5. STORM SAMPLING DATA

NH 4 CONCENTRATION μm

DATE	GB2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/9/93	8.25	2.20	17.23	0.63	2.09	11.86	12.69	4.60	7.12	23.49	1.60	3.02	3.11	2.59
9/27/93	4.02	3.03	3.59	4.07	4.27	6.53	12.41	5.45	5.84	12.69	5.26	2.52	3.14	3.68
11/18/93	1.79	1.49	4.07	33.04	26.97	12.10	3.96	1.23	16.33	29.41	0.91	0.34	1.34	0.58
12/6/93	0.06	3.49	3.17	23.36	9.90	8.16	7.66	1.20	19.67	11.72	2.42	2.06	1.20	73.55
5/3/94	12.85	1.98	2.12	8.09	7.10	1.35	6.20	1.81	13.58	13.30	2.47	2.04	1.79	2.39
5/26/94	5.11	3.08	4.41	8.69	7.91	5.99	11.09	2.79	14.20	36.86	4.81	4.89	5.13	10.66
6/13/94	4.52	6.78	11.78	9.26	20.02	4.95	11.18	4.51	7.56	30.37	3.44	6.30	2.34	5.10
6/22/94	2.69	19.04	3.35	7.822	8.405	15.81	9.26	3.71	8.45	32.35	5.39	4.96	4.62	10.68
MEAN	4.91	5.14	6.21	11.87	10.83	8.34	9.31	3.16	11.59	23.77	3.29	3.27	2.83	13.65
Splits NH4														
8/24/93							5.94		1.84					
9/7/93							3.53		1.14					
10/5/93							16.23		4.82					
11/2/93							0.38							
12/20/93							21.30		18.72					
4/20/94										10.82				
5/18/94			6.25						15.90					
6/15/94									11.97					

NO3 CONCENTRATION μm

DATE	GB2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/9/93	1.45	0.38	4.09	0.81	2.19	1.64	8.05	1.22	32.38	76.69	0.37	1.74	7.08	3.94
9/27/93	2.07	1.31	6.32	6.99	5.27	2.37	3.91	1.46	73.07	91.31	0.66	0.97	6.10	4.04
11/18/93	4.97	9.10	10.17	21.91	12.16	7.06	27.96	7.53	27.41	21.62	9.72	4.79	10.30	25.37
12/6/93	10.05	0.88	15.96	15.42	21.23	8.16	11.67	5.53	16.47	22.71	14.67	7.12	4.92	7.03
5/3/94	5.76	6.81	2.16	3.32	8.62	8.41	10.30	5.31	13.29	11.80	1.39	3.94	1.73	13.95
5/26/94	4.08	1.88	5.43	9.62	5.61	3.85	8.00	0.65	23.38	15.26	5.38	3.43	7.03	16.53
6/13/94	3.91	1.02	4.19	42.43	13.39	3.45	6.07	1.58	44.60	35.30	4.36	4.56	4.54	12.69
6/22/94	0.06	1.11	2.36	15.91	9.70	0.70	3.54	4.60	39.54	53.92	3.57	4.91	3.20	14.22
MEAN	4.04	2.81	6.33	14.55	9.77	4.46	9.94	3.48	33.77	41.08	5.02	3.93	5.61	12.22

TABLE 5. STORM SAMPLING DATA

splits NO3

DATE	GB2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/93							5.13		65.51					
9/7/93							3.63		39.27					
10/5/93							6.27		43.61					
11/2/93							35.12							
12/20/93							8.02		6.38					
4/20/94										5.82				
5/18/94			5.99						13.00					
6/15/94							4.42		50.03					

PO4 CONCENTRATION μm

DATE	GB2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/9/93	1.39	1.04	2.92	2.97	1.42	2.58	2.03	0.96	0.38	0.97	0.33	0.17	0.24	0.29
9/27/93	1.09	0.94	0.89	0.79	0.90	1.70	1.54	1.11	1.30	0.75	0.37	0.21	0.31	0.20
11/18/93	0.72	0.94	0.92	0.97	1.04	1.47	1.51	0.83	1.80	1.42	0.62	0.20	0.35	0.46
12/6/93	0.53	0.86	0.70	1.39	0.55	1.01	1.00	0.68	1.22	0.42	0.77	0.66	0.59	0.60
5/3/94	0.23	0.31	0.22	0.50	0.39	0.47	0.90	0.54	0.72	0.23	0.24	0.17	0.32	0.28
5/26/94	0.55	0.59	0.62	0.63	0.62	0.83	1.30	0.58	1.02	0.58	0.39	0.38	0.45	0.45
6/13/94	0.66	0.79	1.14	1.04	0.95	1.07	0.97	0.59	1.47	1.18	0.32	0.37	0.41	0.27
6/22/94	0.78	0.77	1.04	0.93	0.96	1.22	1.07	0.72	1.38	1.11	0.72	0.48	0.63	0.54
MEAN	0.74	0.78	1.06	1.15	0.85	1.29	1.29	0.75	1.16	0.83	0.47	0.33	0.41	0.39

splits PO4

DATE	GB2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/93							1.60		0.78					
9/7/93							2.22		0.45					
10/5/93							2.14		2.24					
11/2/93							1.41							
12/20/93							1.29		1.06					
4/20/94			0.43							0.52				
5/18/94									0.92					
6/15/94							0.94		1.43					

TABLE 5. STORM SAMPLING DATA

TSS Mg/l

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/9/93	3.80	0.40	3.20	12.80	1.60	2.20	7.80	2.80	7.20	0.60	3.40	0.20	0.80	1.20
9/27/93	1.60	1.40	18.60	1.60	2.40	3.40	30.60	3.00	5.00	3.00	2.60	1.20	3.40	2.40
11/18/93	6.00	3.20	10.00	5.80	4.00	5.40	31.00	9.80	4.60	0.80	7.80	1.00	3.00	9.00
12/6/93	3.40	13.20	24.60	8.40	4.80	5.00	28.20	6.80	7.60	1.20	4.00	7.80	5.00	9.20
5/3/94	6.20	12.20	2.00	7.40	6.20	10.80	37.00	13.60	4.40	3.20	2.00	0.60	1.80	5.40
5/26/94	6.80	4.80	18.40	6.80	7.80	6.60	106.67	11.40	2.20	2.00	2.00	0.80	1.00	3.40
6/13/94	5.40	3.80	9.60	7.00	7.60	5.80	40.00	2.60	3.00	4.40	2.20	3.40	2.00	8.80
6/22/94	6.20	6.40	32.20	5.80	5.80	6.40	19.80	3.60	3.20	3.60	2.80	1.20	1.20	4.20
MEAN	4.93	5.68	14.83	6.95	5.03	5.70	37.63	6.70	4.65	2.35	3.35	2.03	2.28	5.45

% ORGANIC

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/9/93	21.05	50.00	37.50	41.25	52.50	18.18	30.77	21.43	52.78	55.00	58.82	57.00	57.00	62.00
9/27/93	51.00	24.30	9.68	33.33	50.00	23.53	16.99	40.00	64.00	66.67	92.31	66.67	62.35	63.33
11/18/93	26.67	37.50	22.00	34.48	45.00	25.93	16.13	24.49	47.83	50.00	30.77	80.00	60.00	31.11
12/6/93	41.18	21.21	16.26	30.95	37.50	24.00	17.02	32.35	26.32	83.33	60.00	28.21	40.00	26.09
5/3/94	12.90	13.11	50.00	24.32	19.35	20.37	14.41	19.12	36.36	43.75	30.00	66.67	55.56	33.33
5/26/94	26.47	25.00	15.22	29.41	25.64	12.12	15.00	15.79	63.64	60.00	50.00	100.00	80.00	47.06
6/13/94	22.22	15.79	22.92	28.57	23.68	17.24	12.00	38.46	40.00	72.73	63.64	23.53	80.00	45.45
6/22/94	25.81	25.00	13.04	31.03	34.48	18.75	14.14	44.44	56.25	77.78	64.29	83.33	100.00	52.38
MEAN	28.41	26.49	23.33	31.67	36.02	20.02	17.06	29.51	48.40	63.66	56.23	63.18	66.86	45.09

TABLE 5. STORM SAMPLING DATA

SALINITY ppt

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/9/93	32.00	31.00	24.00	24.00	23.00	30.00	22.90	31.00	0.00	0.00	0.00	0.00	0.00	0.00
9/27/93	29.50	31.00	22.00	23.50	22.50	29.50	24.00	31.00	0.00	0.00	0.00	0.00	0.00	0.00
11/18/93	26.00	29.50	6.00	7.80	13.00	25.20	9.00	25.00	0.00	0.00	0.00	0.00	0.00	0.00
12/6/93	24.00	25.00	3.00	0.00	0.00	23.50	2.50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5/3/94	19.00	24.00	0.00	5.00	4.50	20.00	0.00	25.00				0.00		
5/26/94	17.50	23.00	5.50	5.50	5.20	16.50	2.00	24.00	0.00	0.00	0.00	0.00	0.00	0.00
6/13/94	22.00	26.00	16.00	5.00	6.00	21.00	14.00	28.00						
6/22/94	24.00		19.00	15.80	15.50	23.50	17.00							
MEAN	24.25	27.07	11.94	10.83	11.21	23.65	11.43	23.43	0.00	0.00	0.00	0.00	0.00	0.00

TEMPERATURE

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/9/93	20.00	16.00	21.10	21.00	21.00	19.60	22.20	16.50						
9/27/93	14.50	13.00	15.50	15.00	15.00	14.50	15.50	13.00						
11/18/93	7.20	7.00	4.80	6.00	7.20	7.20	4.90	8.00	6.00	5.90	7.00	7.00	7.50	6.50
12/6/93	5.50	5.50	4.80	3.00	4.00	5.20	4.00	6.00	4.50	4.00	3.50	3.50	6.80	4.00
5/3/94	12.00	10.00	13.00	13.00	13.00	11.80	13.00	10.00	11.40	11.20	11.00	13.00	12.50	11.50
5/26/94	14.00		16.80	16.00	15.80	14.50	17.20		17.20	16.50	15.50	17.50	17.50	16.50
6/13/94	18.50		19.80	22.00	20.90	18.80	21.00			22.30	23.70	25.90	27.10	22.10
6/22/94	21.50		22.20	23.00	23.00	22.00	23.50		28.30	24.10	28.80			28.20
MEAN	14.15	10.30	14.75	14.88	14.99	14.20	15.16	10.70	13.48	14.00	14.92	13.38	14.28	14.80

TABLE 5. STORM SAMPLING DATA

pH

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/9/93	7.90	7.97	7.77	8.01	8.05	7.85	7.66	8.05	7.45	7.16	7.12	7.23	7.15	7.45
9/27/93	7.98	8.11	7.45	8.03	8.01	7.99	7.96	7.94	7.55	7.46	7.43	7.30	7.21	7.24
11/18/93	7.90	8.04	7.73	7.52	7.57	7.95	7.57	7.85	7.12	6.86	6.90	6.89	6.77	7.27
12/6/93	7.69	7.77	7.22	7.23	6.92	7.44	6.90	7.61	6.99	7.45	6.86	7.28	7.54	6.93
5/3/94														
5/26/94														
6/13/94														
6/22/94														
MEAN	7.87	7.97	7.54	7.70	7.64	7.81	7.52	7.86	7.28	7.23	7.08	7.18	7.17	7.22

D.O. mg/l

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/9/93	7.40	8.20	7.30	6.20	6.20	7.60	5.90	7.60						
9/27/93	8.20	8.40	7.00	6.00	6.20	8.20	7.20	8.00						
11/18/93	9.60			11.40	9.80	9.50			12.20	10.60	11.40	12.20	12.20	12.40
12/6/93	10.20		14.50			10.50	12.70							
5/3/94	10.50			10.40	9.90	10.45								
5/26/94	7.70		9.00	8.00	7.70	7.80	6.80							
6/13/94	7.20		7.10			7.60	5.90							
6/22/94	6.00		5.00	7.10	7.20	6.20	5.90							
MEAN	8.35	8.30	8.32	8.18	7.83	8.48	7.40	7.80	12.20	10.60	11.40	12.20	12.20	12.40

TABLE 6. DATA FROM RANDOM SAMPLING BY STATE PERSONNEL

NH 4 CONCENTRATION μm

DATE	GB2 um	GB13 um	GB15 um	GB21 um	GB22 um	GB50 um	GB 80 um	HH1A um	7CCH um	5 SFR um	5 BLM um	5 LMP um	9 EXT um	5 OYS um
8/24/94	6.30	6.30	6.30	6.30	6.30	6.30		6.30	6.30	6.30	6.30	6.30	6.30	6.30
9/7/94	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30	6.30
10/5/94	6.30	6.30	6.30	6.30	7.00	6.30	14.00	6.30	6.30	28.00	6.30	6.30	6.30	6.30
11/2/94	6.30	6.30	6.30	7.00	7.70	7.00	6.30	6.30	7.70	9.10	6.30	6.30	6.30	6.30
12/20/94	6.30	6.30	6.30	13.30	9.10	6.30	14.70	6.30	16.80	7.70	6.30	6.30	6.30	6.30
4/19/94	6.30	6.30	6.30		6.30	6.30		6.30	6.30	6.30	6.30	6.30	6.30	6.30
5/17/94	6.30	7.00	6.30	7.00	6.30	6.30			14.00	14.00	6.30	6.30	6.30	6.30
6/14/94	6.30	6.30	6.30	6.30	14.00	6.30	7.00		7.00	21.00	6.30	6.30	6.30	6.30
MEAN	6.30	6.39	6.30	7.50	7.88	6.39	9.10	6.30	8.84	12.34	6.30	6.30	6.30	6.30
STD DEV	0.00	0.25	0.00	2.58	2.67	0.25	4.08	0.00	4.15	8.15	0.00	0.00	0.00	0.00

NO3 CONCENTRATION μm

DATE	GB2 um	GB 13 um	GB15 um	GB 21 um	GB22 um	GB50 um	GB 80 um	HH 1A um	7 CCH um	5 SFR um	5BLM um	5 LMP um	9 EXT um	5 OYS um
8/24/94	1.26	1.26	3.50	8.40	4.20	2.80	8.40	1.26	60.90	44.10	1.26	1.26	5.46	1.26
9/7/94	1.26	1.26	1.26	1.26	1.26	1.40	1.26	7.70	39.90	84.00	1.26	1.26	1.26	1.26
10/5/94	4.20	6.30	9.10	28.00	29.40	4.90	13.30	6.30	54.60	94.50	25.20	18.20	2.10	12.60
11/2/94	5.60	11.20	7.00	18.20	18.20	4.90	25.20	9.10	25.20	21.70	8.40	4.90	4.20	23.10
12/20/94	14.70	21.70	7.70	11.20	11.20	16.80	4.20		11.90	11.90	8.40	7.00	12.60	16.10
4/19/94	9.80	8.40	5.60	10.50	9.80	8.40			9.80	9.10	3.15	6.30	5.60	11.20
5/17/94	4.90	4.20	4.20	9.10	8.40	9.10			11.20	10.50	5.60	4.20	3.50	9.10
6/14/94	7.00	7.00	9.80	25.90	21.70	7.00	9.80		39.20	32.20	4.20	7.00	5.60	9.10
MEAN	6.09	7.67	6.02	14.07	13.02	6.91	10.36	6.09	31.59	38.50	7.18	6.27	5.04	10.47
STD DEV	4.48	6.62	2.93	9.20	9.42	4.78	8.41	3.42	20.12	33.63	7.80	5.34	3.46	7.27

PO4 CONCENTRATION μm

DATE	GB 2 um	GB 13 um	GB 15 um	GB 21 um	GB 22 um	GB 50 um	GB 80 um	HH 1A um	7 CCH um	5 SFR um	5 BLM um	5 LMP um	9 EXT um	5 OYS um

TABLE 6. DATA FROM RANDOM SAMPLING BY STATE PERSONNEL

	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/94	1.18	0.68	1.83	1.27	1.40	1.71	1.27	0.84	0.56	0.22	0.16	0.12	0.12	0.25
9/7/94	1.02	0.71	2.11	0.93	1.05	1.52	1.74	0.96	0.03	0.53	0.03	0.03	0.03	0.03
10/5/94	0.65	0.90	2.33	0.74	0.68	1.36	2.05	0.65	1.40	0.96	0.12	0.06	0.03	0.06
11/2/94	0.71	0.81	0.62	0.68	0.71	0.99	1.05	1.12	1.02	0.59	0.06	0.28	0.22	0.09
12/20/94	2.51	1.27	0.78	1.12	1.12	1.61	2.14		1.89	0.81	1.30	0.78	0.99	1.05
4/19/94	0.06	0.56	0.12	0.25	0.31	0.22			0.90	0.37	0.03	0.19	0.03	0.06
5/17/94	0.34	0.37	0.22	0.43	0.40	0.68	-		0.56	0.22	0.03	0.03	0.12	0.03
6/14/94	0.71	0.65	0.84	0.62	0.81	0.99	0.93		1.21	0.74	0.31	0.28	0.12	0.19
MEAN	0.90	0.74	1.10	0.76	0.81	1.14	1.53	0.89	0.95	0.55	0.25	0.22	0.21	0.22
STD DEV	361.37	0.27	0.86	0.34	0.37	0.51	0.52	0.20	0.57	0.27	0.43	0.25	0.32	0.35

TSS mg/liter

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/94	8.00	6.00	24.50	20.50	19.00	40.00	41.50	11.00	7.00	9.00	1.50	0.09	1.50	2.50
9/7/94	25.00	5.00	6.00	11.00	13.50	8.00	8.50	11.00	7.00	1.00	5.50	3.00	4.00	1.00
10/5/94	51.00	55.00	37.00	30.00	36.00	52.00	57.00	57.00	3.00	3.00	5.00	5.00	3.00	6.00
11/2/94	14.00	3.00	43.00	19.00	87.00	70.00	36.00	56.00	1.00	3.00	1.00	0.90	2.00	0.09
12/20/94	5.00	6.50	19.00	5.00	6.00	5.00	17.00		4.80	4.40	3.20	4.00	4.50	4.00
4/19/94	3.00	1.00	12.00	3.00	1.00	4.00			2.00	0.90	1.00	0.90	1.00	1.00
5/17/94	5.50	2.50	12.50	6.00	7.00	5.50			4.00	4.00	2.00	1.00	2.00	4.50
6/14/94	5.50	2.00	7.00	5.50	3.50	4.50	35.00		2.00	3.00	2.00	3.00	2.00	9.00
MEAN	14.63	10.13	20.13	12.50	21.63	23.63	32.50	33.75	3.85	3.54	2.65	2.24	2.50	3.51
STD DEV	16.34	18.24	13.75	9.65	28.70	26.44	17.41	26.27	2.28	2.54	1.75	1.76	1.22	3.00

% ORGANIC

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/93	31.25	16.67	24.49	36.59	34.21	30.00	27.71	27.27						

TABLE 6. DATA FROM RANDOM SAMPLING BY STATE PERSONNEL

	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/94	1.18	0.68	1.83	1.27	1.40	1.71	1.27	0.84	0.56	0.22	0.16	0.12	0.12	0.25
9/7/94	1.02	0.71	2.11	0.93	1.05	1.52	1.74	0.96	0.03	0.53	0.03	0.03	0.03	0.03
10/5/94	0.65	0.90	2.33	0.74	0.68	1.36	2.05	0.65	1.40	0.96	0.12	0.06	0.03	0.06
11/2/94	0.71	0.81	0.62	0.68	0.71	0.99	1.05	1.12	1.02	0.59	0.06	0.28	0.22	0.09
12/20/94	2.51	1.27	0.78	1.12	1.12	1.61	2.14		1.89	0.81	1.30	0.78	0.99	1.05
4/19/94	0.06	0.56	0.12	0.25	0.31	0.22			0.90	0.37	0.03	0.19	0.03	0.06
5/17/94	0.34	0.37	0.22	0.43	0.40	0.68			0.56	0.22	0.03	0.03	0.12	0.03
6/14/94	0.71	0.65	0.84	0.62	0.81	0.99	0.93		1.21	0.74	0.31	0.28	0.12	0.19
MEAN	0.90	0.74	1.10	0.76	0.81	1.14	1.53	0.89	0.95	0.55	0.25	0.22	0.21	0.22
STD DEV	361.37	0.27	0.86	0.34	0.37	0.51	0.52	0.20	0.57	0.27	0.43	0.25	0.32	0.35

TSS mg/liter

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/94	8.00	6.00	24.50	20.50	19.00	40.00	41.50	11.00	7.00	9.00	1.50	0.09	1.50	2.50
9/7/94	25.00	5.00	6.00	11.00	13.50	8.00	8.50	11.00	7.00	1.00	5.50	3.00	4.00	1.00
10/5/94	51.00	55.00	37.00	30.00	36.00	52.00	57.00	57.00	3.00	3.00	5.00	5.00	3.00	6.00
11/2/94	14.00	3.00	43.00	19.00	87.00	70.00	36.00	56.00	1.00	3.00	1.00	0.90	2.00	0.09
12/20/94	5.00	6.50	19.00	5.00	6.00	5.00	17.00		4.80	4.40	3.20	4.00	4.50	4.00
4/19/94	3.00	1.00	12.00	3.00	1.00	4.00			2.00	0.90	1.00	0.90	1.00	4.00
5/17/94	5.50	2.50	12.50	6.00	7.00	5.50			4.00	4.00	2.00	1.00	2.00	4.50
6/14/94	5.50	2.00	7.00	5.50	3.50	4.50	35.00		2.00	3.00	2.00	3.00	2.00	9.00
MEAN	14.63	10.13	20.13	12.50	21.63	23.63	32.50	33.75	3.85	3.54	2.65	2.24	2.50	3.51
STD DEV	16.34	18.24	13.75	9.65	28.70	26.44	17.41	26.27	2.28	2.54	1.75	1.76	1.22	3.00

% ORGANIC

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/93	31.25	16.67	24.49	36.59	34.21	30.00	27.71	27.27						

TABLE 6. DATA FROM RANDOM SAMPLING BY STATE PERSONNEL

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
9/7/93	32.00	20.00	33.33	54.55	51.85	25.00	17.65							
10/5/93	23.53	1.82	35.14	26.67	16.67	17.31	21.05	21.05						
11/2/93	7.14		18.60	21.05	18.39	25.71	16.67	19.64						
12/20/93	20.00	15.38	13.16		25.00		17.65							
4/19/94	33.00	100.00	8.33	33.00	100.00	25.00								
5/17/94														
6/14/94														
MEAN	24.49	30.77	22.18	34.37	41.02	24.60	20.15	22.65	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
STD DEV	9.97	39.31	10.80	12.75	31.64	4.58	4.54	4.06	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

SALINITY

DATE	GB 2	GB 13	GB 15	GB 21	GB 22	GB 50	GB 80	HH 1A	7 CCH	5 SFR	5 BLM	5 LMP	9 EXT	5 OYS
8/24/93	26.00	26.00	23.50	21.00	23.50	27.00	22.00		0.00	0.00	0.00	0.00	26.00	0.00
9/7/93	30.00	30.50	27.00	20.00	21.00	30.00	28.00		0.00	0.00	0.00	0.00	30.50	0.00
10/5/93	26.00	29.00	14.00	10.00	12.00	26.00	18.00	29.00	0.00	0.00	0.00	0.00	29.00	0.00
11/2/93	22.00	26.00	8.00	2.00	3.00	22.00	8.00	28.00	0.00	0.00	0.00	0.00	26.00	0.00
12/20/93	14.00	24.00	0.00	0.00	0.00	13.00	0.00	29.00	0.00	0.00	0.00	0.00	24.00	0.00
4/19/94	10.00	25.00	0.00	2.00	6.00	12.00			0.00	0.00	0.00	0.00	25.00	0.00
5/17/94	14.00	23.00		2.00	1.00	12.00			0.00	0.00	0.00	0.00		0.00
6/14/94									0.00	0.00	0.00	0.00		0.00
MEAN	20.29	26.21	12.08	8.14	9.50	20.29	15.20	28.67	0.00	0.00	0.00	0.00	26.75	0.00
STD DEV	7.61	2.67	11.53	9.03	9.59	7.80	11.19	0.58	0.00	0.00	0.00	0.00	2.48	0.00

Table 6A. Rainfall conditions relative to sampling dates and classification based on the following criteria:
    Wet=>0.25" prior to sampling on sample date and previous day; Dry=<0.25".

DATE	Sampling Agency	Inches of rain on sample date & previous day	Condition classification
24-Aug-93	DES	0/0	Dry
7-Sep	DES	0/0	Dry
9-Sep	JEL	0.5/0.66	Wet
27-Sep	JEL	1.19/2.16	Wet
5-Oct	DES	0.05/0.05	Dry
2-Nov	DES	trace/0.6	Wet
18-Nov	JEL	0.83/1.15	Wet
6-Dec	JEL	0/1.55	Wet
20-Dec	DES	trace/0.05	Dry
19-Apr-94	DES	0.05/0.05	Dry
3-May	JEL	0/0.06	Dry
17-May	DES	0.25/0.6	Wet
26-May	JEL	trace/0.42	Wet
13-Jun	JEL	0.45/0.8	Wet
14-Jun	DES	0.03/0.48	Wet
22-Jun	JEL	0/0.19	Dry

Table 7. Split sample analysis of bacterial indicators by State and JEL labs.

Fecal coliforms

DATE	JEL	STATE	JEL	STATE			
	Freshwater Sites		Tidal Sites				
24-Aug	1260	220	9.5	7			
7-Sep	293	133	9	5			
5-Oct	TNTC	166	25	6			
2-Nov	ND	48	76	67			
20-Dec	84	22	83	46			
19-Apr	48	29	36	20			
17-May	150	112	82	55	Overall data		
14-Jun	5	200	5	23		JEL	State
Geometric mean	101.9	86.5	25.8	18.9		46.5	36.3
Standard deviation	6.4	2.7	3.1	2.8		4.9	3.5

E. coli

DATE	JEL	STATE	JEL	STATE			
	Freshwater Sites		Tidal Sites				
24-Aug	1250	1390	9.5	6			
7-Sep	193	240	9	6			
5-Oct	TNTC	330	12.5	13			
2-Nov	ND	80	38	90			
20-Dec	76	25	76	51			
19-Apr	26	21	27	34			
17-May	138	90	78	61	Overall data		
14-Jun	4	189	0.8	16		JEL	State
Geometric mean	80.1	120.0	16.4	22.7		32.3	46.4
Standard deviation	7.0	4.8	4.4	2.8		6.2	4.5

Enterococci

DATE	JEL	STATE	JEL	STATE			
	Freshwater Sites		Tidal Sites				
24-Aug	48	70	1.5	9			
7-Sep	25	50	3	9			
5-Oct	72	80	6	10			
2-Nov	ND	60	111	60			
20-Dec	12	20	51	40			
19-Apr	0	9	6	6			
17-May	20	20	7	7	Overall data		
14-Jun	29	130	10	10		JEL	State
Geometric mean	14.8	31.7	10.8	17.9		12.4	22.9
Standard deviation	5.9	2.4	4.4	3.2		4.7	2.8

Table 8. Regression analysis of fecal coliform concentrations for paired split samples.

Fecal coliform	MPN	per 100 ml
JEL	DES: raw	DES: modified
1260	220	1390
293	133	240
84	22	25
48	29	29
150	112	112
5	200	200
9.5	7	7
9	5	6
25	6	13
76	67	90
83	46	51
36	20	34
82	55	61
5	23	23

Regression Statistics:	raw data
R Square	0.45
Standard Error	55.14
Observations	14

Regression Statistics:	modified data
R Square	0.97
Standard Error	61.20
Observations	14

JEL fecal coliform levels compared to paired DES (modified) levels.
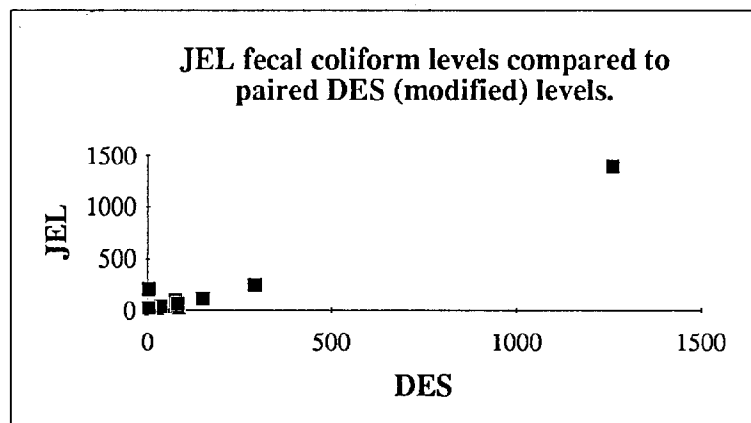
Table 9. Regression analysis of E. coli concentrations for paired split samples.

E. coli	MPN per 100 ml
JEL	DES
1250	1390
193	240
76	25
26	21
138	90
4	189
9.5	6
9	6
12.5	13
38	90
76	51
27	34
78	61
0.8	16

Regression Statistics:	
R Square	0.97
Standard Error	61.86
Observations	14

JEL E. coli levels compared to paired DES levels.
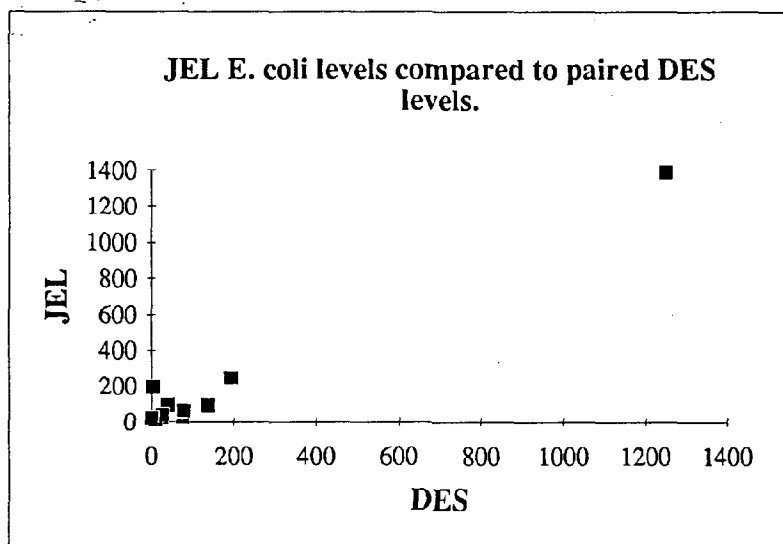
Table 10. Regression analysis of enterococci concentrations for paired split samples.

Enterococci	MPN per 100 ml
JEL	DES
48	70
25	50
72	80
12	20
0.5	9
20	20
29	130
1.5	9
3	9
6	10
111	60
51	40
6	6
7	7
10	10

Regression Statistics:	
R Square	0.36
Standard Error	30.27
Observations	15

JEL enterococci levels compared to paired DES levels.
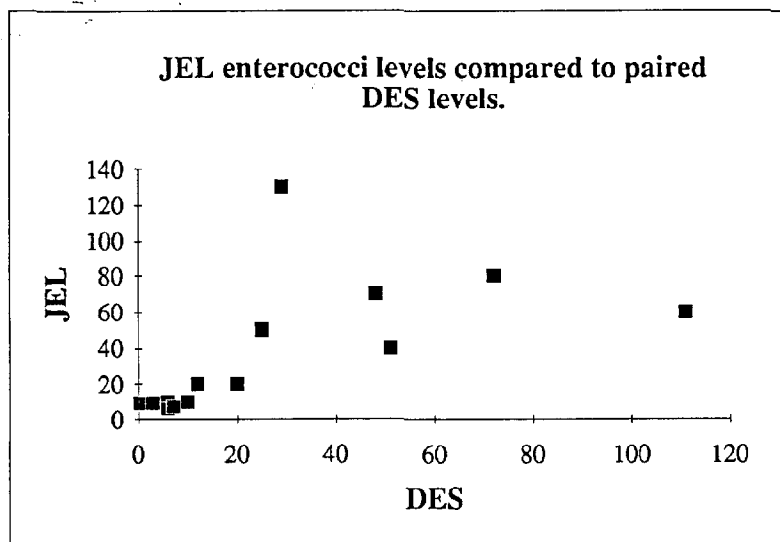
Table 11. Bacterial indicator concentrations at all study sites sampled by JEL following rain storms.

FECAL COLIFORMS

DATE	5-SFR	7-CCH	5-BLM	5-OYS	5-LMP	9-EXT	GB22	GB21	GB2	GB50	GB15	GB80	GB13	HH1A
9-Sep	10	3110	103	660	40	1240	258	1180	10.5	4.5	160	17.5	35	464
27-Sep	14	2800	36	1160	30	820	100	140	19.5	2.5	3040	280	190	40
18-Nov	132	3600	180	1520	50	460	405	645	210	54.5	200	160	165	84
6-Dec	120	360	90	420	328	260	110	540	75	58	360		15	
3-May	73	59	53	100	19	77	27	86	14	2.25	27	86	56	49
26-May	143	102	85	210	16	115	111	295	47	55	165	60	6.25	61.25
13-Jun	40	325	130	3200	70	210	5700	5500	35	52.5	355	22.5	5	40
22-Jun	217.5	72.5	220	75	15	32.5	55	100	6.25	11.25	100	70	5.5	2.75
Geom. ave.	61	447	97	472	40	228	180	410	29	15	220	67	25	47

E. COLI

DATE	5-SFR	7-CCH	5-BLM	5-OYS	5-LMP	9-EXT	GB22	GB21	GB2	GB50	GB15	GB80	GB13	HH1A
9-Sep	4	1300	53	310	25	480	186	820	9	4.5	110	12	23	420
27-Sep	7	2200	18	880	20	640	100	120	19.5	2.5	2990	270	134	40
18-Nov	53	3200	172	1300	44	440	320	625	198	41	200	150	130	84
6-Dec	108	240	90	420	323	240	90	350	60	53	340		10	
3-May	47	47	43	59	18	67	15	70	3.25	1.25	27	64	56	47
26-May	98	9	83	130	15	112.5	43	200	16.5	54	142	20	6.25	55
13-Jun	35	305	115	3000	60	195	500	4200	33.75	52.5	425	17.5	3	40
22-Jun	127.5	37.5	220	75	14	27.5	45	100	6.25	8.75	100	62.5	5	1.25
Geom. ave.	37	239	78	356	34	184	97	326	20	13	209	49	20	41

ENTEROCOCCI

DATE	5-SFR	7-CCH	5-BLM	5-OYS	5-LMP	9-EXT	GB22	GB21	GB2	GB50	GB15	GB80	GB13	HH1A
9-Sep	8.5	85	10	28	80	100	68.5	52.5	74	72	60	92	15	73
27-Sep	8	268	10	262	17.5	80	24	14	98	0.8	4180	30	118	60
18-Nov	13.5	120	700	1930	84	233	190	265	240	70	200	400	70	98
6-Dec	52	210	240	1020	403	505	265	345	260	196	350		75	
3-May	3	5	12	50	9	4	14	6	0.5	10	10	14	8	14
26-May	30.5	37	43.5	102	3	16	16	124	17	59	112.5	135	10	55
13-Jun	46	90	22	75	155	7.5	60	257.5	19	10	60	5	3	32
22-Jun	3	39	14	50	11.5	20	3	0.8	9	3	10	0.8	1	3
Geom. ave.	13	66	36	151	35	42	37	42	30	19	102	26	15	32

Table 12. Bacterial indicator concentrations at all study sites sampled by NH DES under random meteorological conditions.

FECAL COLIFORMS

DATE	5-SFR	7-CCH	11-CCH	22-CCH	5-BLM	5-OYS	8-OYS	5-LMP	9-EXT	14-EXT	GB2	GB13	GB15	GB21	GB22	GB50	GB80	HH1A
24-Aug	4	220			3	6		4	6		5	0.8	60	54	11	1	7	10
7-Sep	2	133			7	5		5	51		1	1	15	74	8	4	5	5
5-Oct	4	166			6	13		2	8		8	1	50	91	41	0.8	6	26
2-Nov	220	48			168	122		16	105		60	5	43	183	220	14	67	8
20-Dec	23	22			2	9		6	16		5	12	49	177	47	4	46	
19-Apr	29	12			7	8		4	26		2	20	20	29	30	0.8		
17-May	98	112	125	75	71	183	145	46	220	220	20	11	55	146	36	31	23	
14-Jun	200	200	112	92	133	158	200	24	57	18	28	2	70	330	106	22	23	
Geom. ave.	23	78	118	83	15	24	170	8	33	63	8	3	41	106	38	4	16	10

E. COLI

DATE	5-SFR	7-CCH	11-CCH	22-CCH	5-BLM	5-OYS	8-OYS	5-LMP	9-EXT	14-EXT	GB2	GB13	GB15	GB21	GB22	GB50	GB80	HH1A
24-Aug	6	1390			4	21		3	12		4	0.8	115	63	6	4	6	11
7-Sep	1	240			10	20		4	98		2	3	18	137	27	7	6	9
5-Oct	6	330			3	41		3	10		15	3	131	108	88	2	13	25
2-Nov	280	80			280	140		40	190		90	10	50	230	200	30	90	8
20-Dec	46	25			6	23		15	19		4	11	61	140	44	11	51	
19-Apr	21	21			8	10		8	16		4	23	34	22	8	3		
17-May	130	90	140	160	79	360	160	52	240	800	28	7	64	190	47	32	16	
14-Jun	280	189	169	95	110	133	192	30	62	21	4	5	105	220	97	14	16	
Geom. ave.	28	129	154	123	19	48	175	11	42	130	8	5	61	114	38	8	18	12

ENTEROCOCCI

DATE	5-SFR	7-CCH	11-CCH	22-CCH	5-BLM	5-OYS	8-OYS	5-LMP	9-EXT	14-EXT	GB2	GB13	GB15	GB21	GB22	GB50	GB80	HH1A
24-Aug	10	70			10	9		10	9		9	9	9	10	9	9	9	40
7-Sep	10	50			60	10		20	20		10	9	9	9	9	9	9	9
5-Oct	9	80			9	20		9	9		10	9	50	40	9	20	10	30
2-Nov	110	60			270	390		70	250		40	20	60	100	90	20	60	20
20-Dec	10	20			9	10		50	9		10	10	40	50	30	9	40	
19-Apr	9	9			10	9		20	10		9	9	9	10	10	9		
17-May	20	20	300	30	70	170	30	9	80	170	30	10	90	90	20	20	40	
14-Jun	70	130	30	20	20	110	70	9	60	10	20	9	50	240	40	9	10	
Geom. ave.	18	41	95	24	26	32	46	18	25	41	14	10	27	37	21	11	16	22

Table 13. Geometric average concentrations for bacterial indicators at all sites common to JEL and DES.

	5-SFR	7-CCH	5-BLM	5-OYS	5-LMP	9-EXT	GB22	GB21	GB2	GB50	GB15	GB80	GB13	HH1A
FECAL COLIFORMS														
JEL	61.4	447.2	96.8	472.0	39.8	228.2	179.5	410.3	28.7	15.0	220.3	67.5	25.1	47.1
DES	23.5	78.1	15.2	23.7	8.0	32.8	7.8	3.5	40.5	106.4	37.9	4.2	15.7	10.1
DES (modified)	31.5	133.9	20.7	48.7	12.1	44.9	11.0	5.7	60.9	127.3	50.2	8.9	19.7	12.0
Combined	38.0	186.8	38.3	105.7	17.9	86.5	37.4	37.7	34.1	40.0	91.4	15.4	20.5	26.9
Combined (modified)	44.0	244.7	44.8	151.6	21.9	101.2	44.4	48.3	41.8	43.7	105.2	22.9	22.6	28.6
Wet	72.4	419.5	100.6	471.8	41.8	250.4	142.6	129.5	45.8	45.9	228.9	42.2	30.7	55.9
Wet (modified)	79.7	444.0	107.7	516.5	48.1	272.6	154.9	154.9	49.5	48.5	235.7	46.6	31.9	55.9
Dry	16.5	66.1	11.1	15.5	6.0	22.1	6.7	7.7	23.4	33.5	28.1	4.8	12.0	11.2
Dry (modified)	20.5	113.8	14.5	31.3	8.0	28.3	17.2	15.3	33.7	38.3	37.2	10.2	14.3	12.8
E. COLI														
JEL	36.7	238.9	77.7	355.8	33.6	184.0	96.9	325.7	19.8	12.9	209.0	49.0	19.5	40.6
DES	27.8	129.4	18.5	47.6	11.3	42.2	8.1	5.3	60.9	113.5	38.2	8.4	18.0	11.9
Combined	31.9	175.8	38.0	130.2	19.5	88.1	28.1	41.6	34.7	38.2	89.4	19.1	18.9	26.0
Wet	56.2	272.2	88.8	418.0	41.9	232.8	78.7	122.8	41.8	44.4	220.5	35.1	23.9	54.0
Dry	15.4	100.3	12.7	29.1	7.3	25.3	7.5	10.4	27.3	31.6	28.0	9.6	13.7	10.8
ENTEROCOCCI														
JEL	12.5	66.3	35.8	151.4	35.1	41.6	36.8	42.3	30.0	18.5	102.1	26.1	14.7	31.6
DES	18.3	40.9	25.6	32.3	17.8	25.4	14.5	10.2	26.8	37.5	20.8	11.0	16.4	21.6
Combined	15.1	52.1	30.3	69.9	25.0	32.5	23.1	20.8	28.3	26.4	46.1	16.5	15.4	27.5
Wet	27.9	87.4	56.7	210.3	36.8	80.1	49.9	53.9	66.8	46.5	126.9	35.8	25.3	49.7
Dry	6.9	26.8	13.5	17.0	15.2	10.2	8.6	6.1	9.4	12.7	12.5	6.8	8.0	13.5

Table 14. Concentrations and geometric mean levels (per 100 ml) of bacterial indicators at routine freshwater sampling sites and sites upstream of routine sites.

FECAL COLIFORMS

DATE	7-CCH	11-CCH	22-CCH	5-OYS	8-0YS	9-EXT	14-EXT
24-Aug	220			6		6	
7-Sep	133			5		51	
5-Oct	166			13		8	
2-Nov	48			122		105	
20-Dec	22			9		16	
19-Apr	12			8		26	
17-May	112	125	75	183	145	220	220
14-Jun	200	112	92	158	200	57	18
Geometric average	78	118	83	24	170	33	63

E. COLI

DATE	7-CCH	11-CCH	22-CCH	5-OYS	8-OYS	9-EXT	14-EXT
24-Aug	1390			21		12	
7-Sep	240			20		98	
5-Oct	330			41		10	
2-Nov	80			140		190	
20-Dec	25			23		19	
19-Apr	21			10		16	
17-May	90	140	160	360	160	240	800
14-Jun	189	169	95	133	192	62	21
Geom. ave.	129	154	123	48	175	42	130

ENTEROCOCCI

DATE	7-CCH	11-CCH	22-CCH	5-OYS	8-OYS	9-EXT	14-EXT
24-Aug	70			9		9	
7-Sep	50			10		20	
5-Oct	80			20		9	
2-Nov	60			390		250	
20-Dec	20			10		9	
19-Apr	9			9		10	
17-May	20	300	30	170	30	80	170
14-Jun	130	30	20	110	70	60	10
Geom. ave.	41	95	24	32	46	25	41
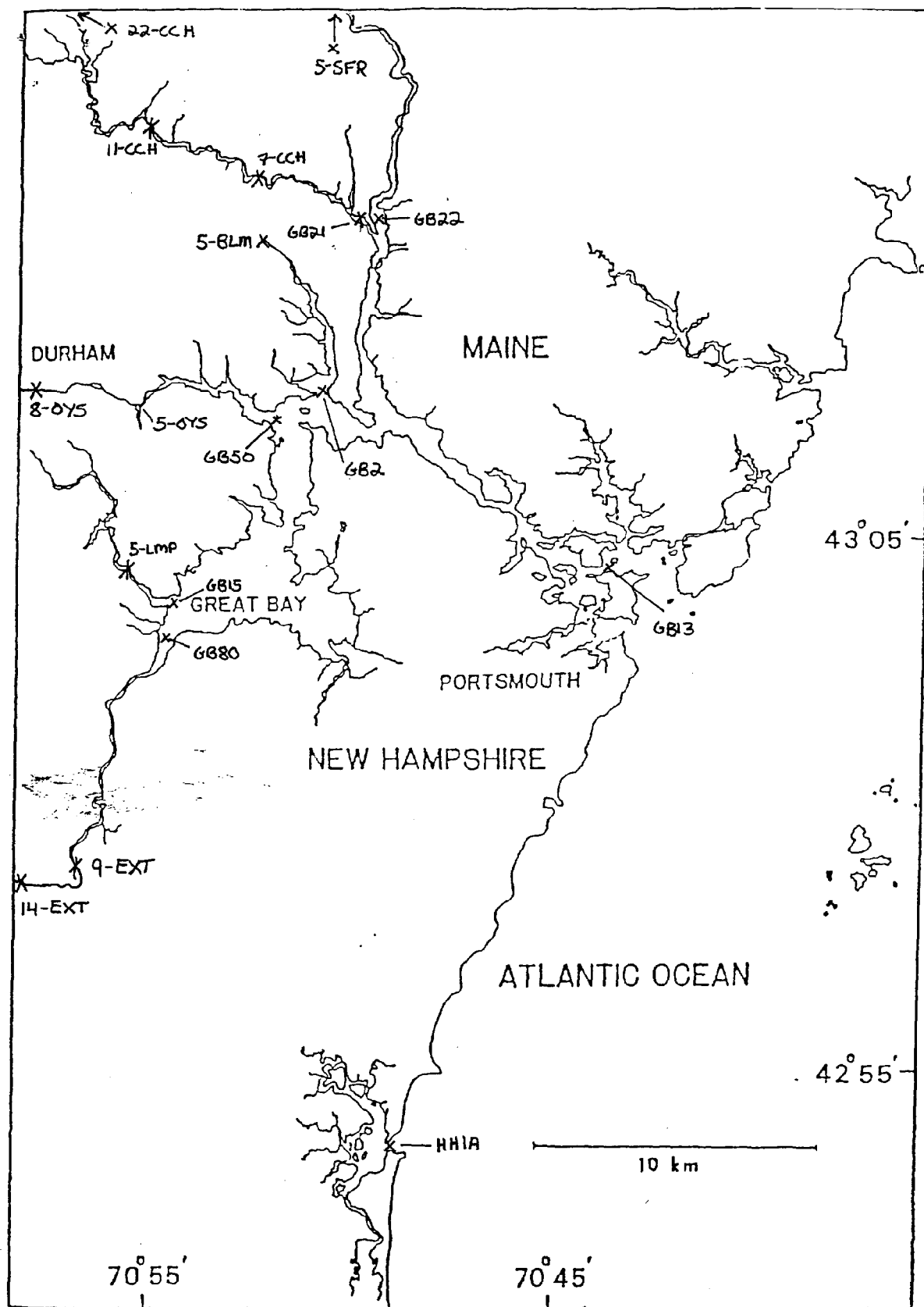
Figure 1. Sampling sites for the tributary NPS study: 1993-94.

FIGURE 1A. MEAN NH4 CONCENTRATION FOR ALL SAMPLES COMBINED
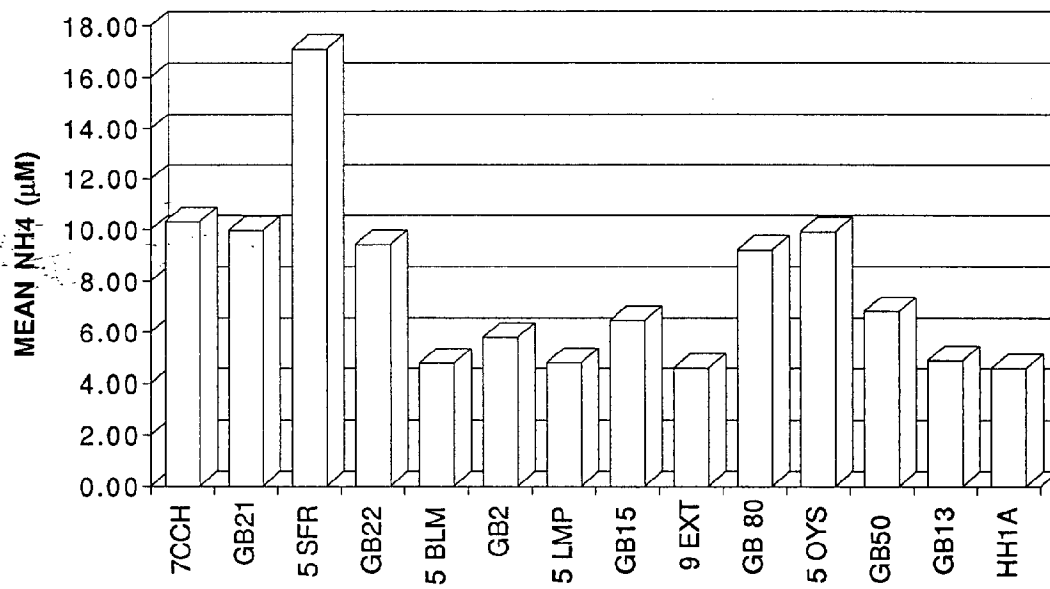
FIGURE 2. MEAN NO3 CONCENTRATION FOR ALL SAMPLES COMBINED
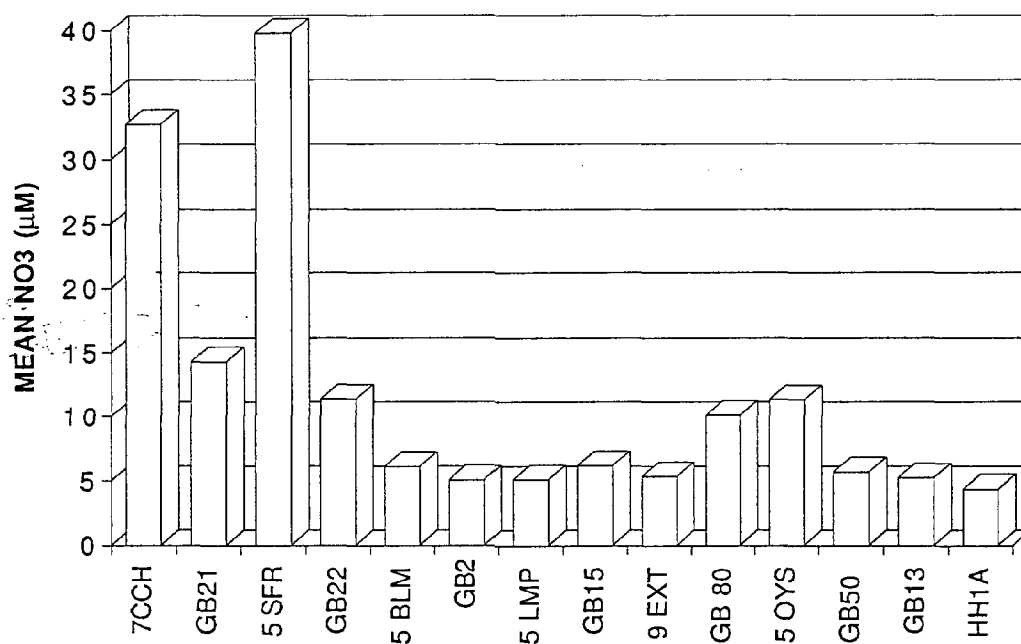
FIGURE 3. MEAN PO4 CONCENTRATION FOR ALL SAMPLES COMBINED
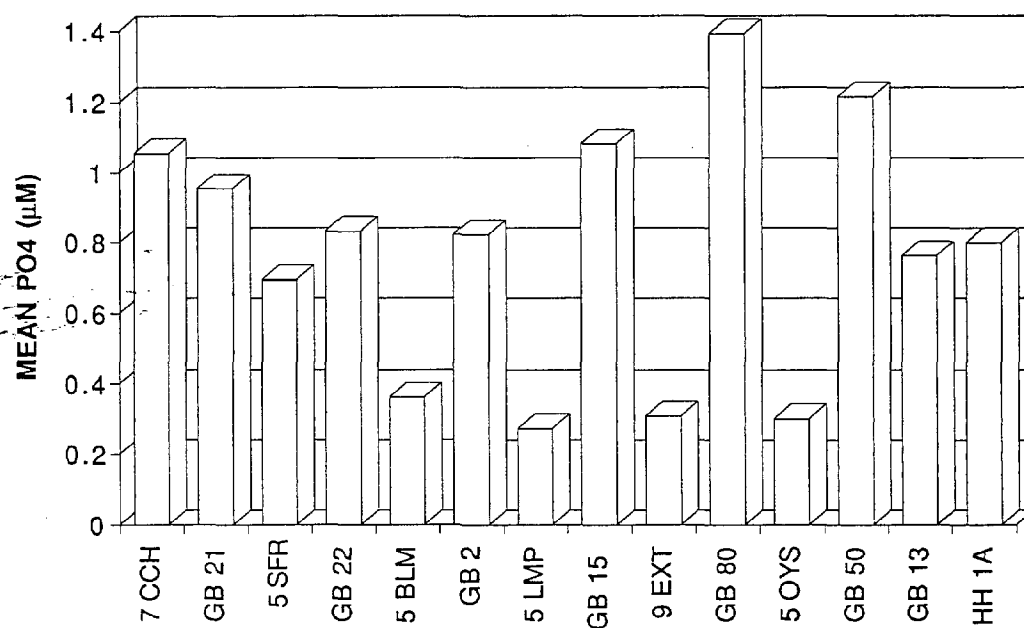
FIGURE 4. MEAN TOTAL SUSPENDED SOLIDS FOR ALL SAMPLES COMBINED
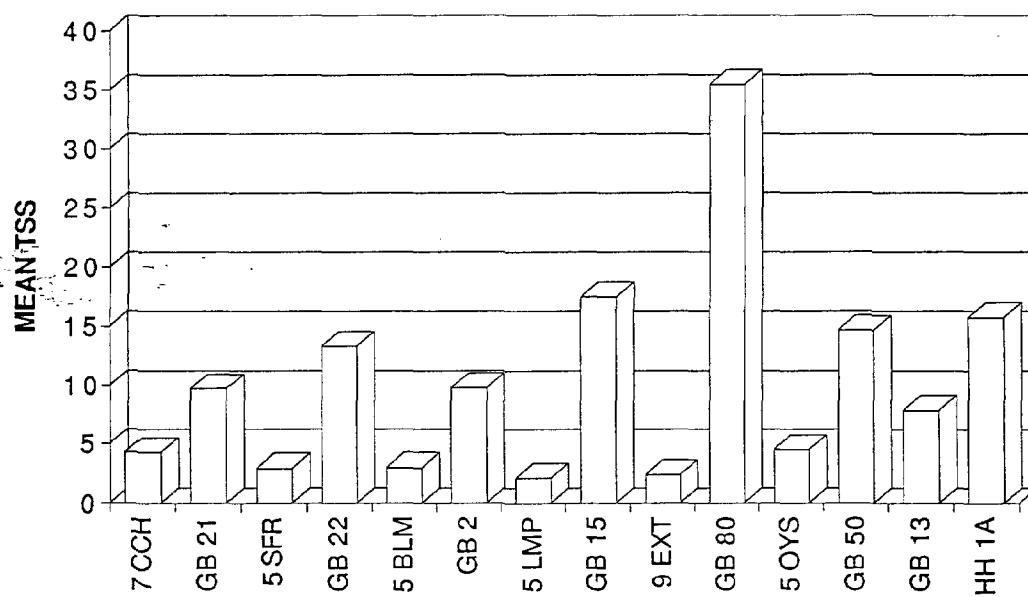
FIGURE 5. MEAN NH4 CONCENTRATION (μM) FOR STORM SAMPLES
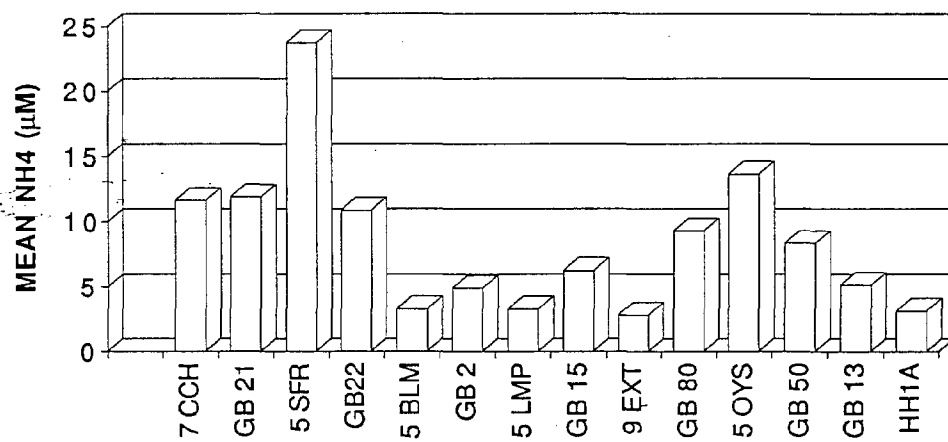
FIGURE 6. MEAN NO3 CONCENTRATION (μM) FOR STORM SAMPLES
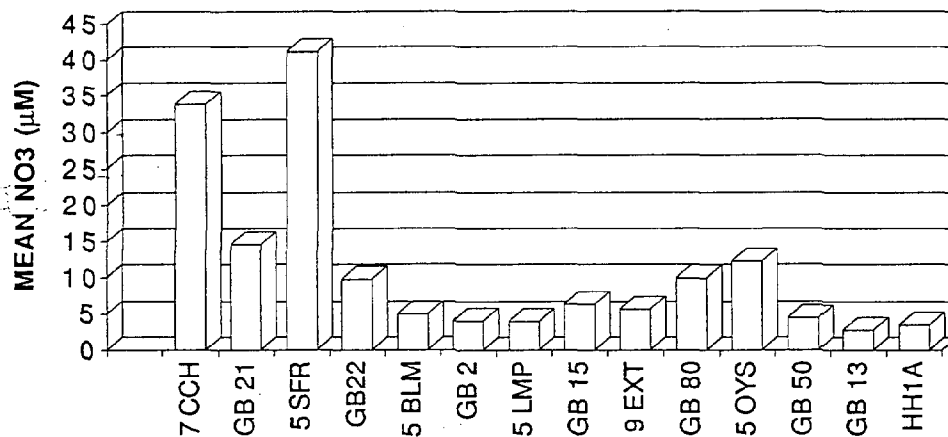
FIGURE 7. MEAN PO4 CONCENTRATION (µM) FOR STORM SAMPLES
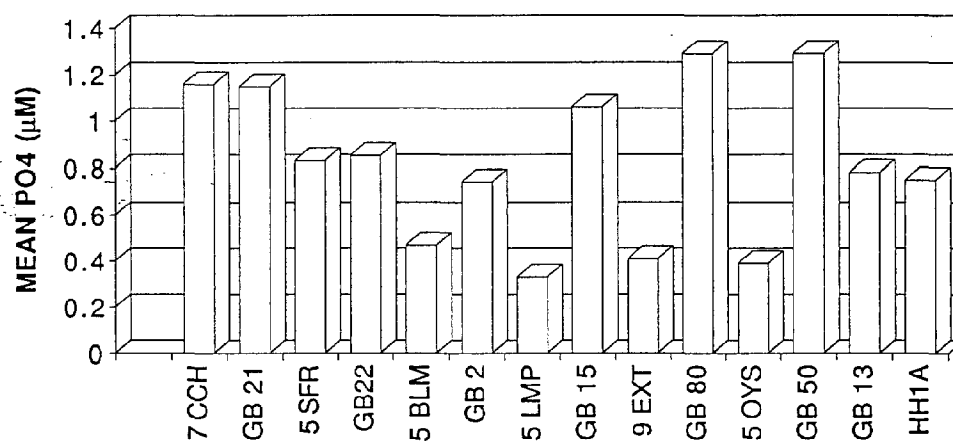
FIGURE 8. MEAN TSS (mg/l) FOR STORM SAMPLES
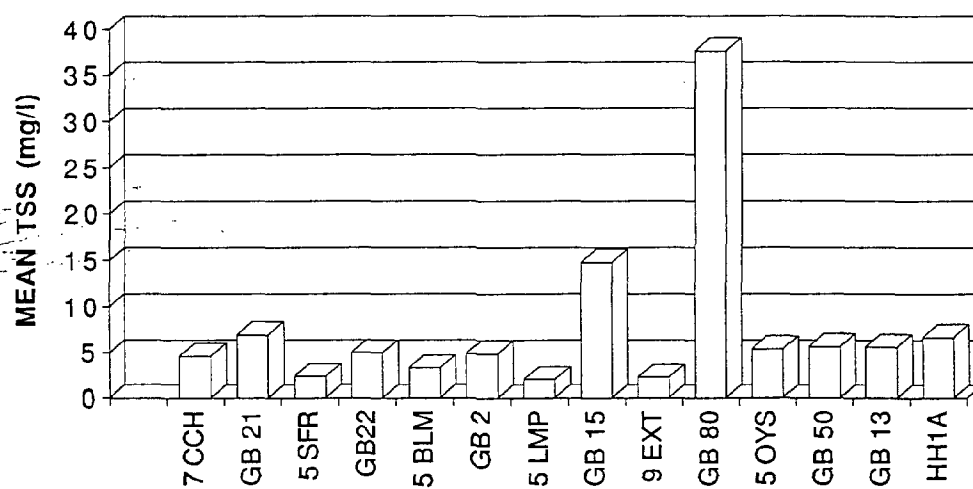
FIGURE 9. MEAN % ORGANIC CONTENT FOR STORM SAMPLES
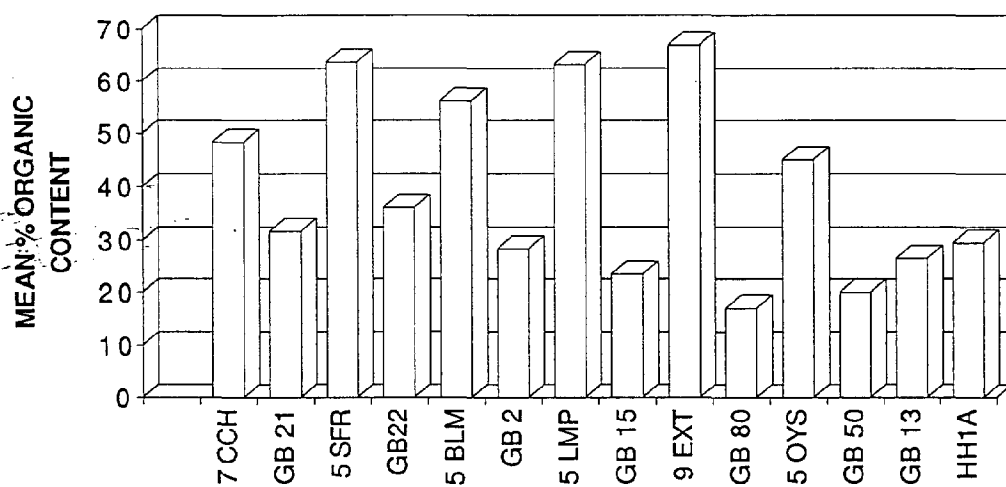
FIGURE10. MEAN STORM SAMPLING SALINITY AT TIDAL STATIONS
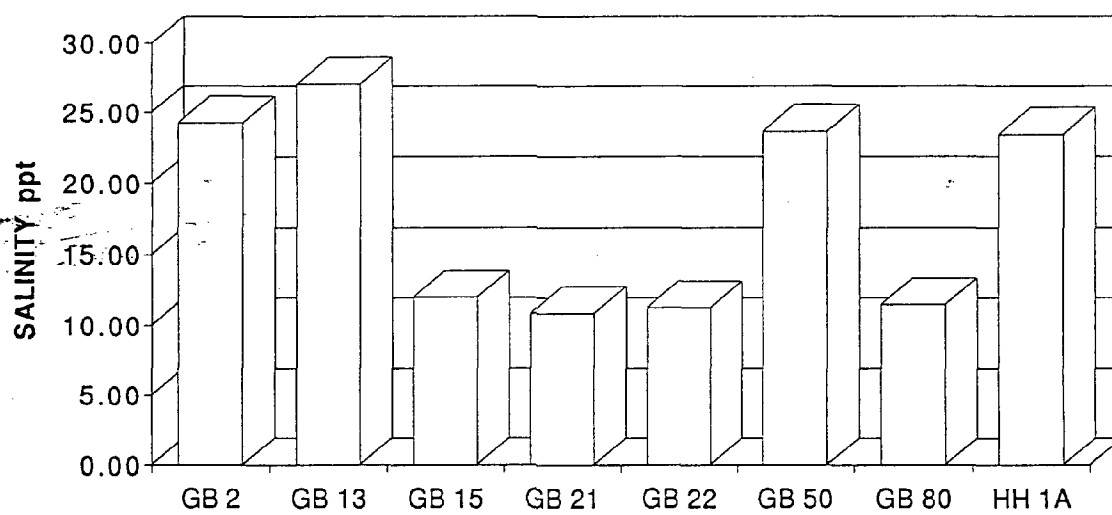
FIGURE 11. MEAN pH FOR STORM SAMPLES
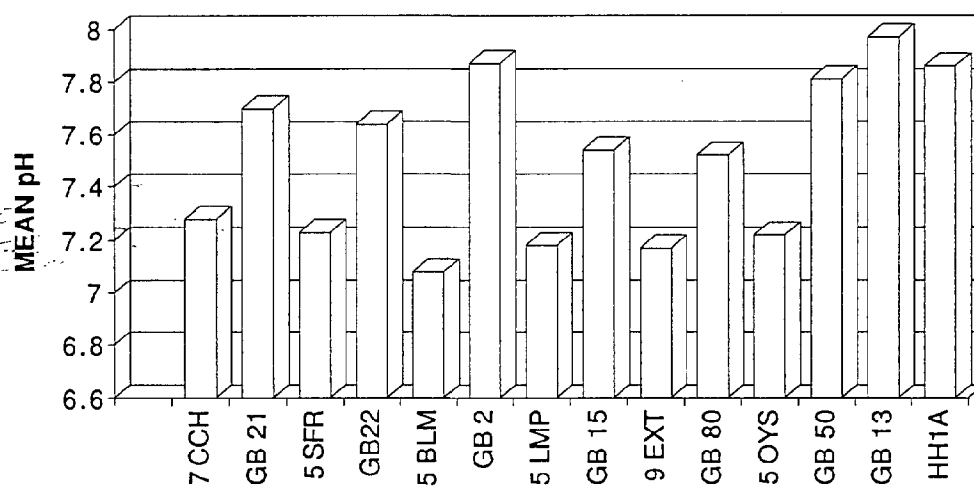
FIGURE 12. COMPARISON OF MEAN NH4 CONCENTRATIONS FOR STORM SAMPLES AND RANDOM SAMPLES
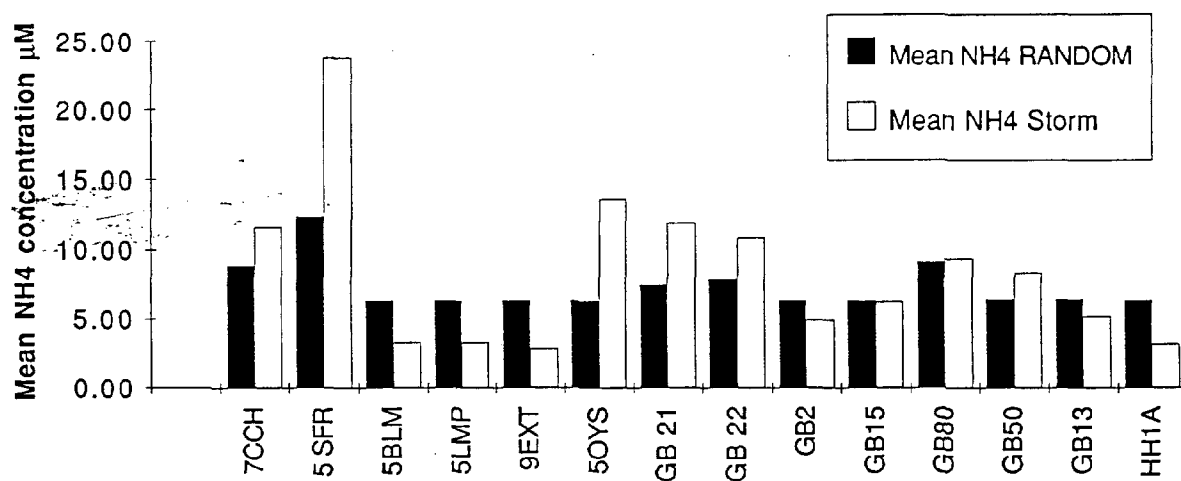
FIGURE 13. COMPARISON OF MEAN NO3 CONCENTRATIONS FOR STORM SAMPLES AND RANDOM SAMPLES

Legend:
- ■ Mean NO3 RANDOM
- □ Mean NO3 Storm

Y-axis: MEAN NO3 CONCENTRATION μM (0, 5, 10, 15, 20, 25, 30, 35, 40, 45)

X-axis categories: 7CCH, 5SFR, 5BLM, 5LMP, 9EXT, 5OYS, GB 21, GB 22, GB2, GB15, GB80, GB50, GB13, HH1A
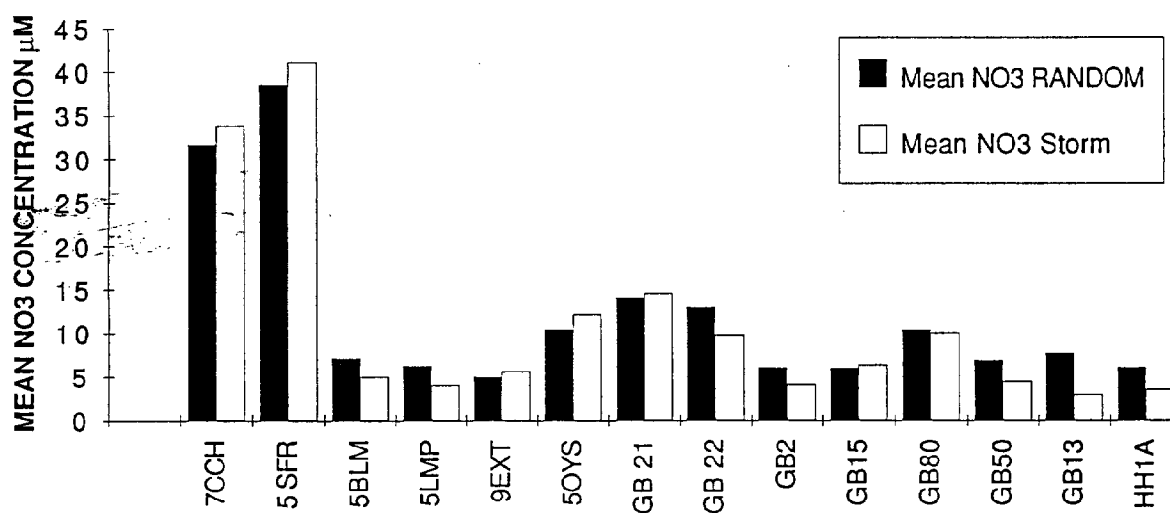
FIGURE 14. COMPARISON OF MEAN PO4 CONCENTRATION FOR STORM SAMPLES AND RANDOM SAMPLES
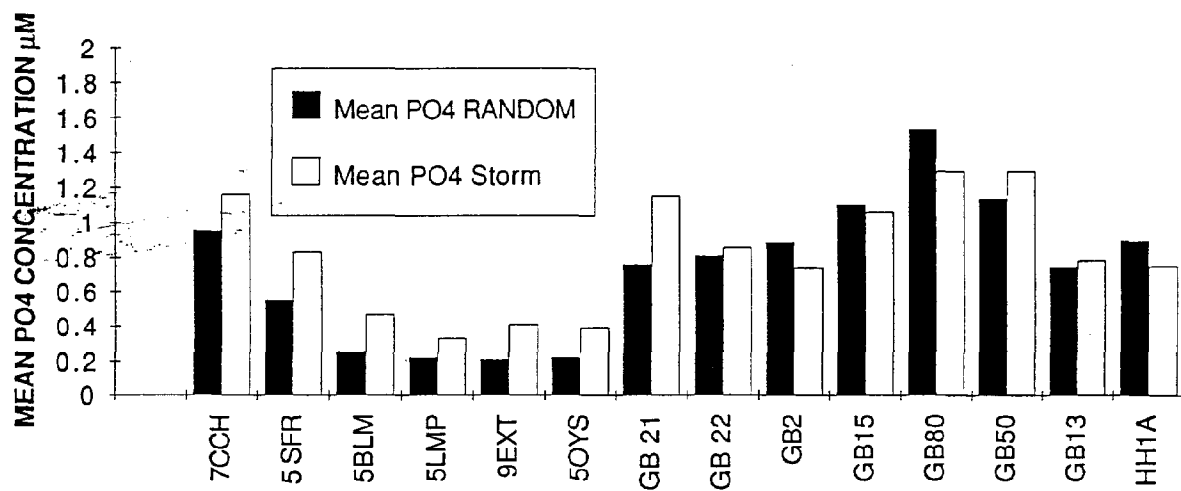
FIGURE 15. COMPARISON OF MEAN TSS (mg/l) FOR STORM SAMPLES AND RANDOM SAMPLES
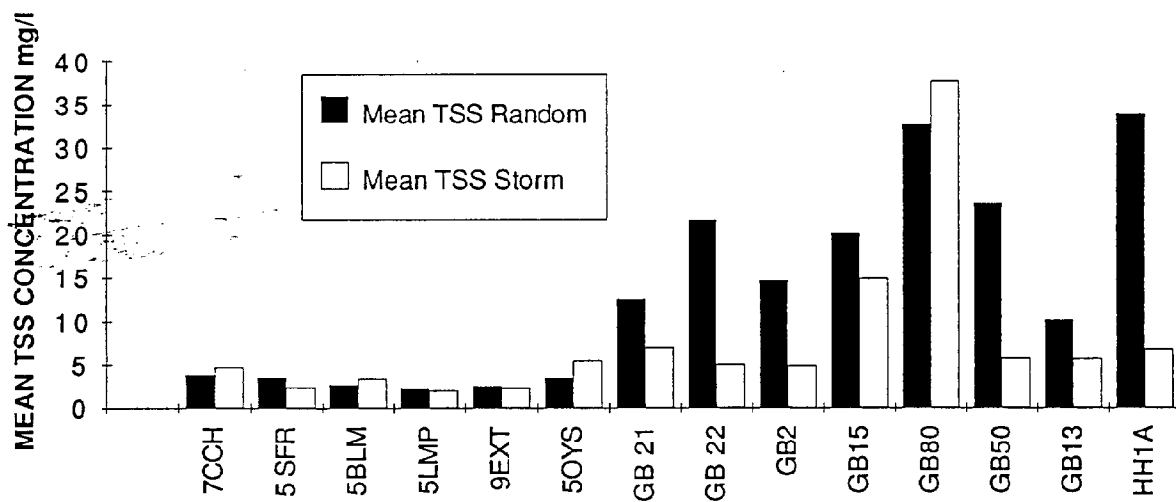
FIGURE 16. COMPARISON OF MEAN NH4 CONCENTRATION IN DRY AND WET SAMPLES
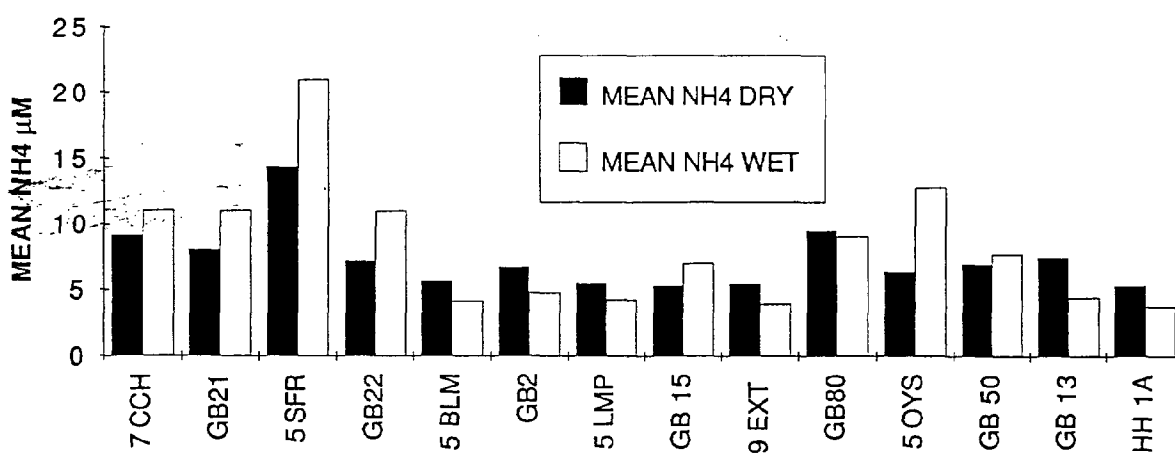
FIGURE 17. MEAN NO3 CONCENTRATION FOR DRY AND WET SAMPLES
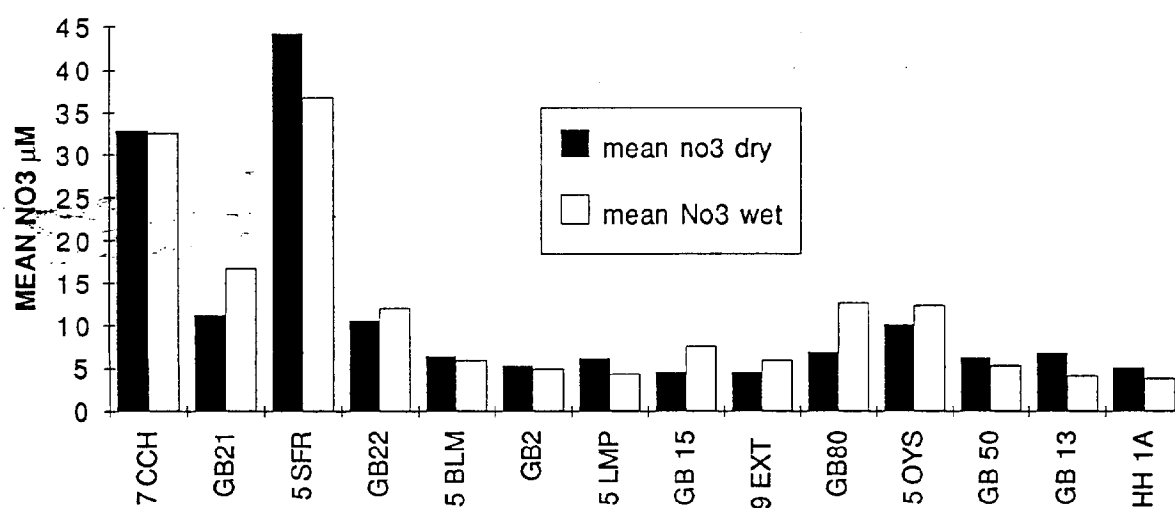
FIGURE 18. MEAN PO4 CONCENTRATION FOR DRY AND WET SAMPLES
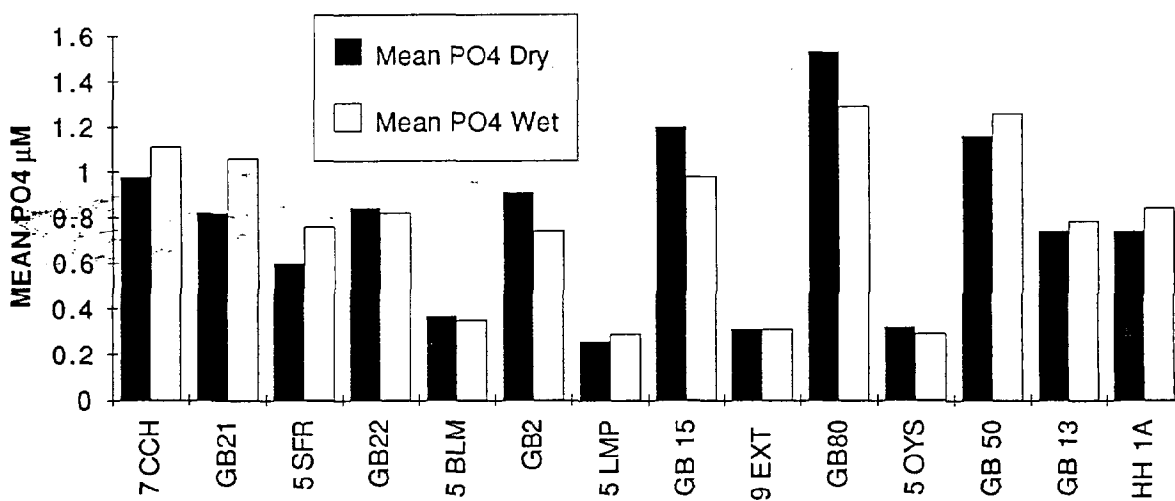
FIGURE 19. COMPARISON OF MEAN TSS CONCENTRATION FOR DRY AND WET SAMPLES
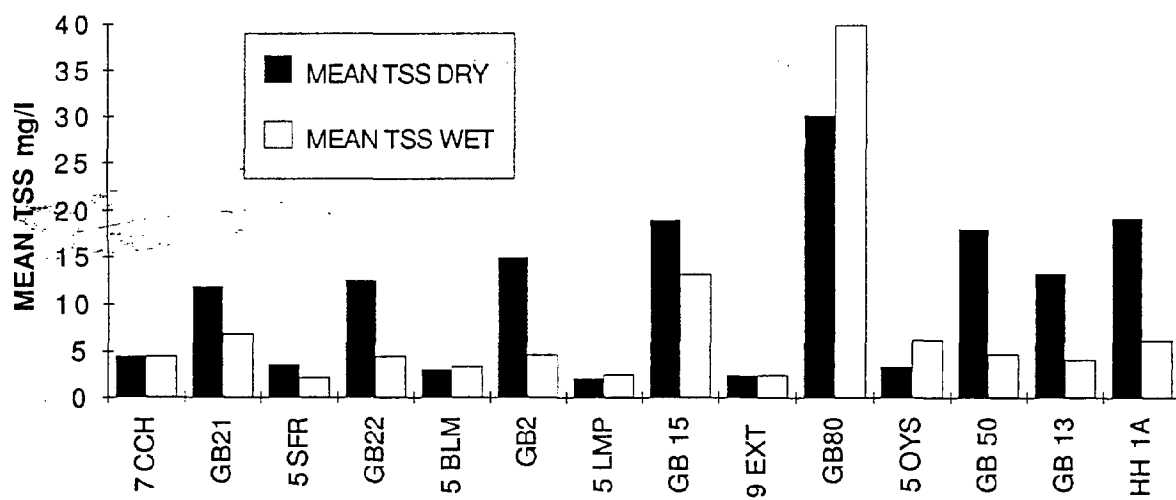
FIGURE 19. COMPARISON OF MEAN TSS CONCENTRATION FOR DRY AND WET SAMPLES
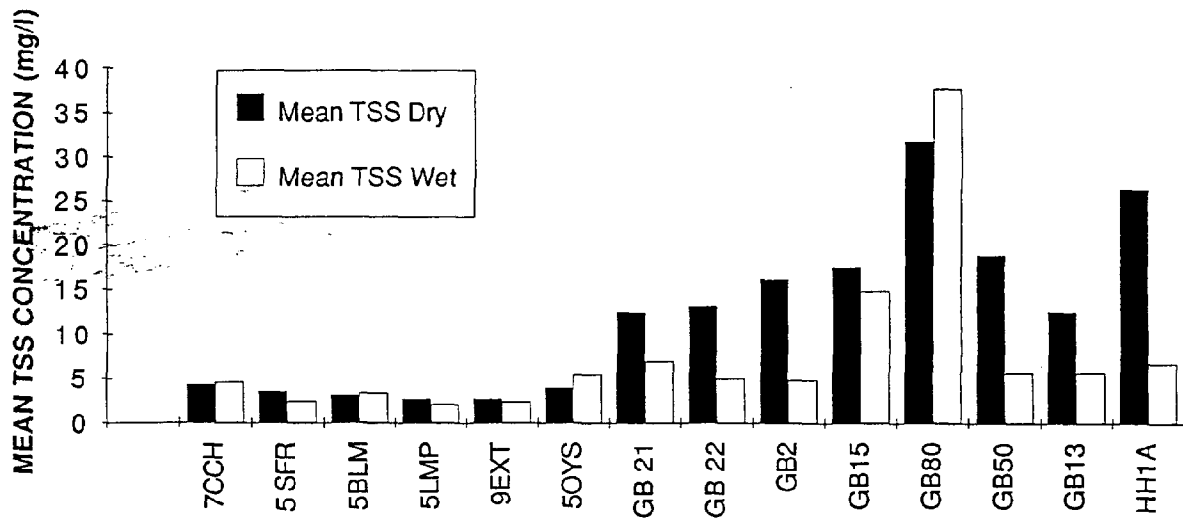
Figure 20. NH4 concentrations at FW and estuarine sites on the Cocheco and Salmon Falls Rivers
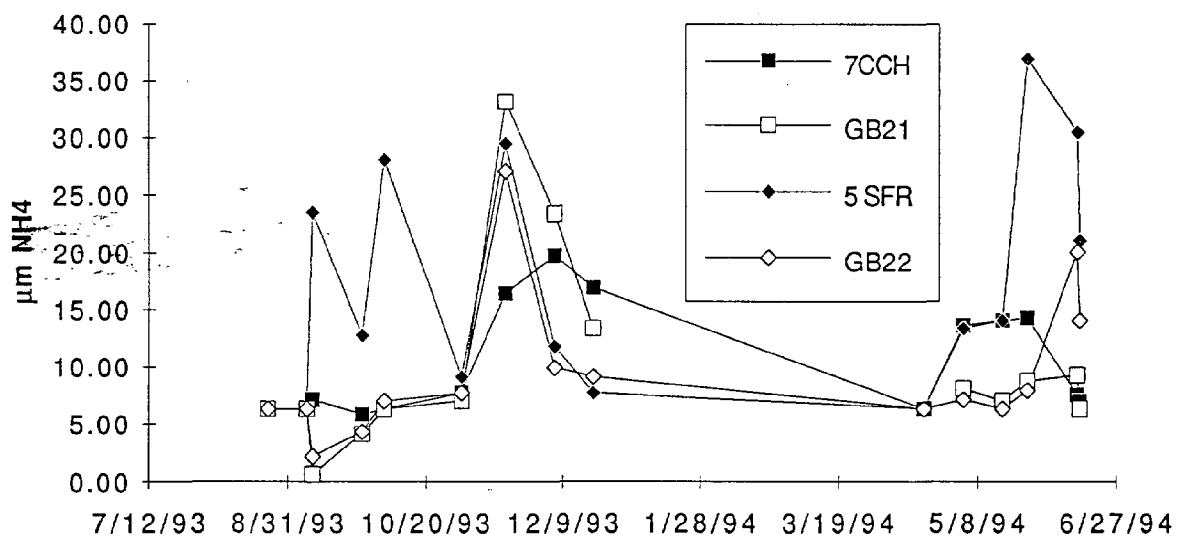
Figure 21. NH4 concentration at FW and estuarine sites on the Bellamy and Lamprey Rivers
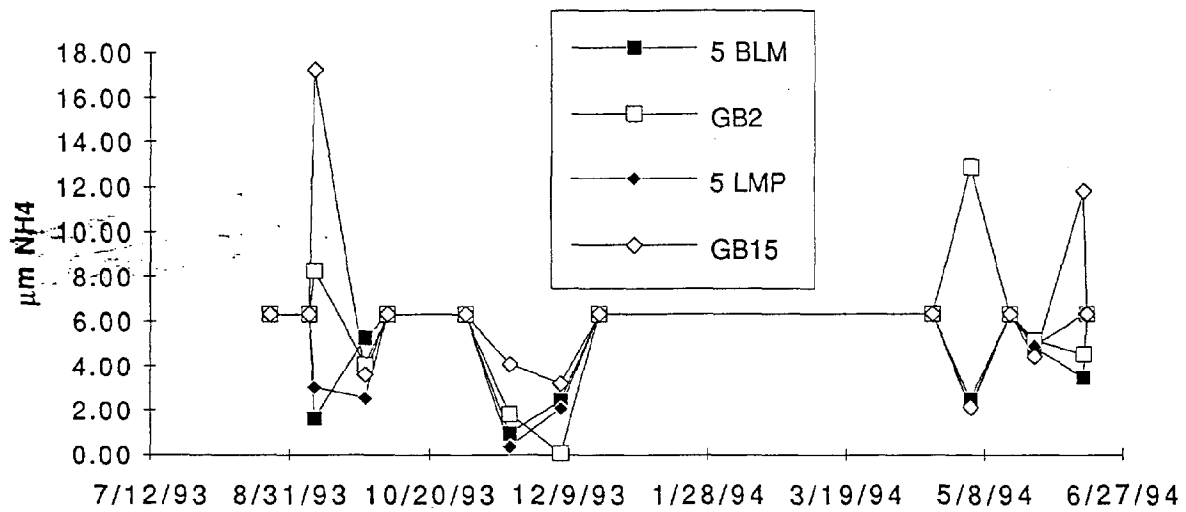
Figure 22. NH4 concentrations at FW and estuarine sites on the Exeter and Oyster Rivers
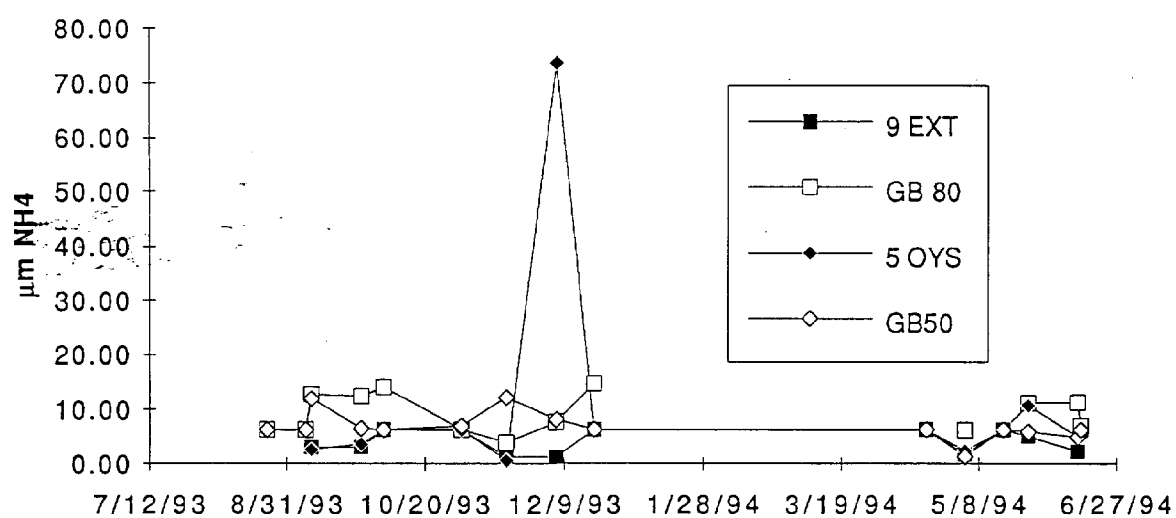
Figure 23. NH4 concentrations at the Piscataqua River and Hampton Harbor
sites
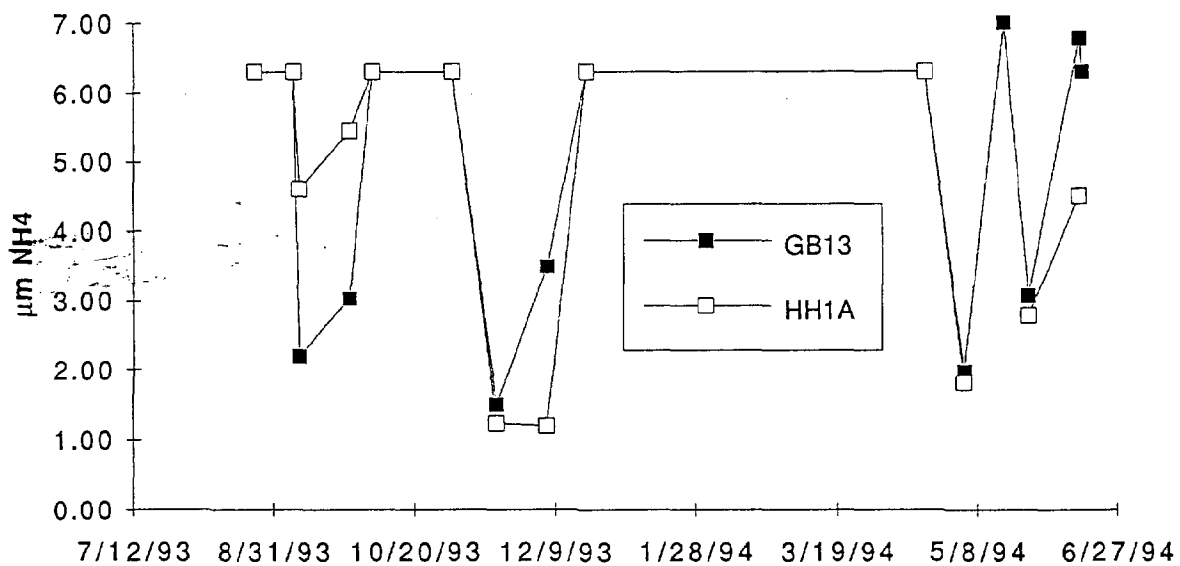
Figure 24. NO3 concentrations at FW and estuarine sites on the Cocheco and Salmon Falls Rivers
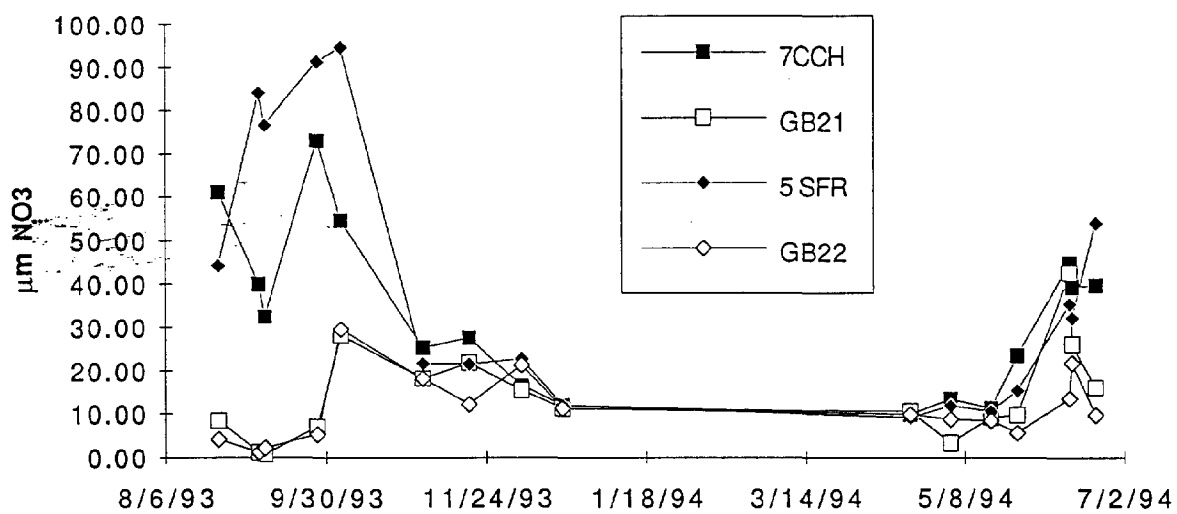
Figure 25. NO3 concentrations at FW and estuarine sites on the Bellamy
and Lamprey Rivers
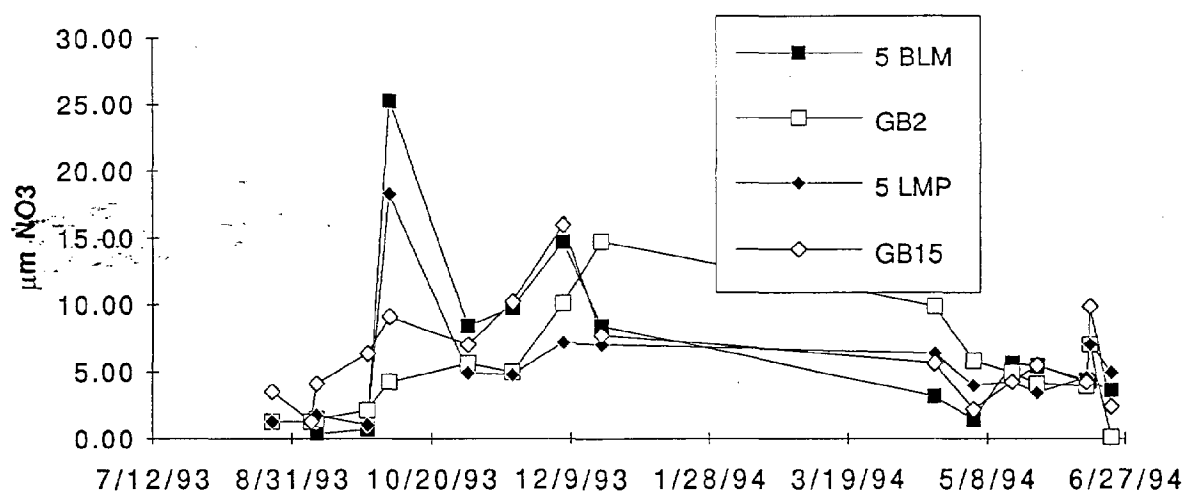
Figure 26. NO3 concentrations at FW and estuarine sites on the Exeter and Oyster Rivers
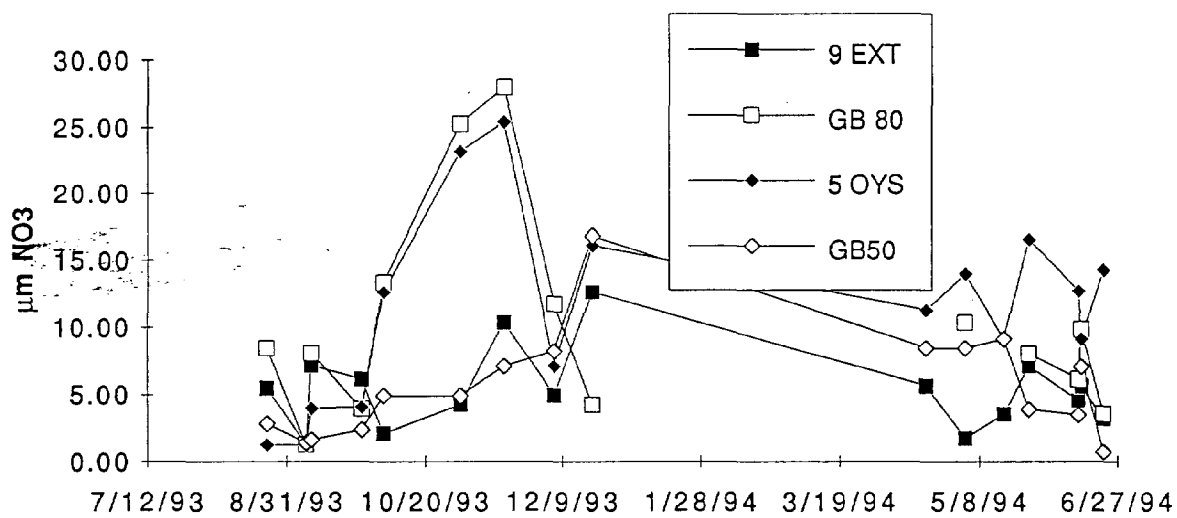
Figure 27. NO3 concentrations at the Piscataqua River and Hampton Harbor sites
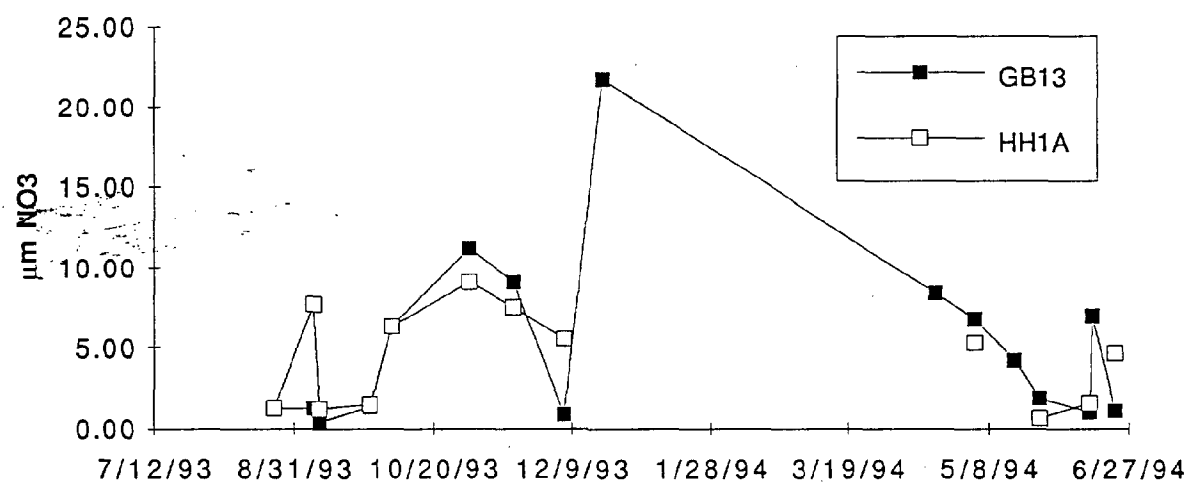
Figure 28. PO4 concentrations at FW and estuarine sites on the Cocheco and Salmon Falls Rivers
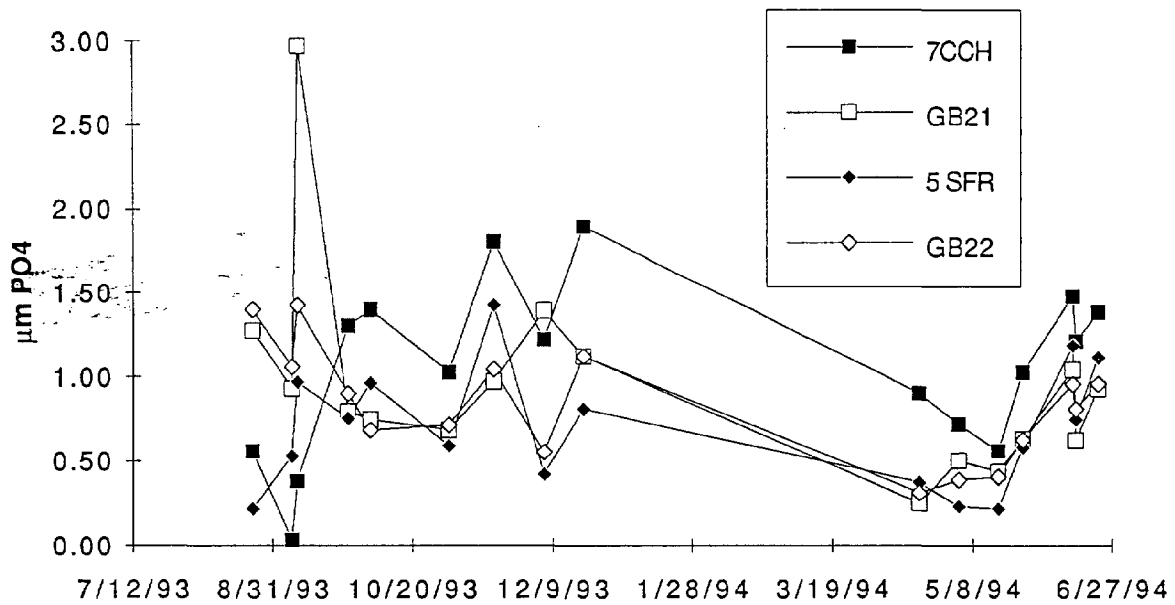
Figure 29. PO4 concentrations at FW and estuarine sites on the Bellamy and Lamprey Rivers
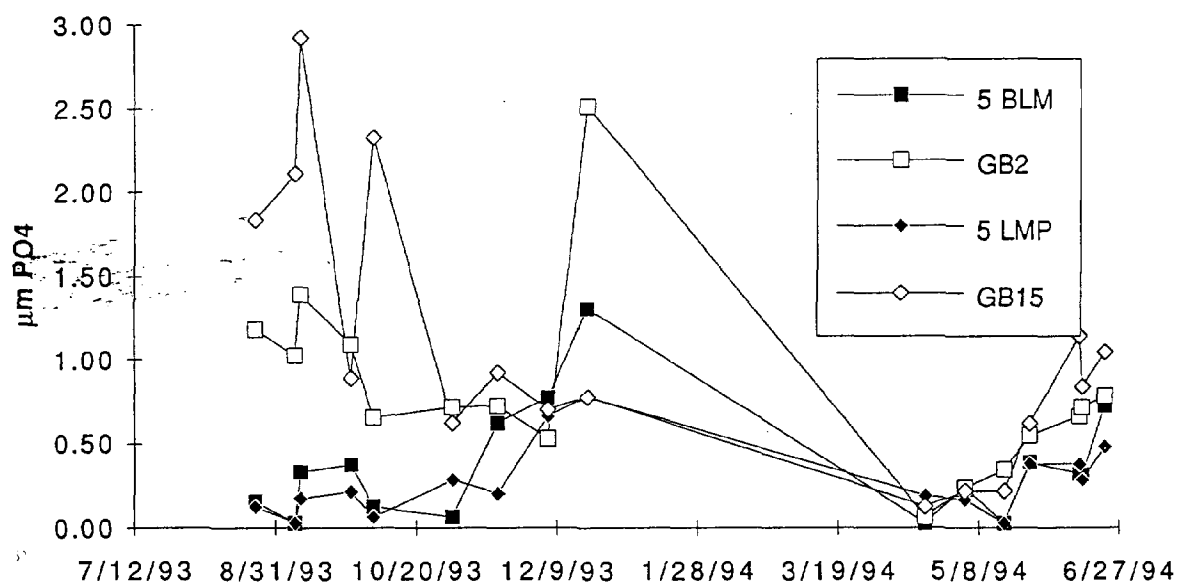
Figure 30. PO4 concentrations at FW and estuarine sites on the Exeter and Oyster Rivers
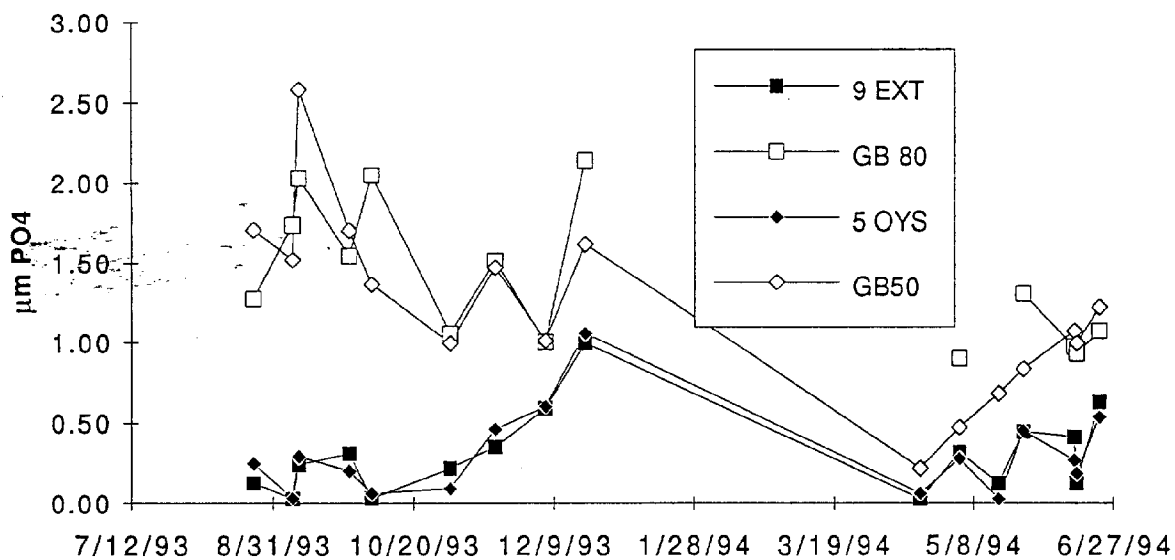
Figure 31. PO4 concentrations at the Piscataqua River and Hampton Harbor sites
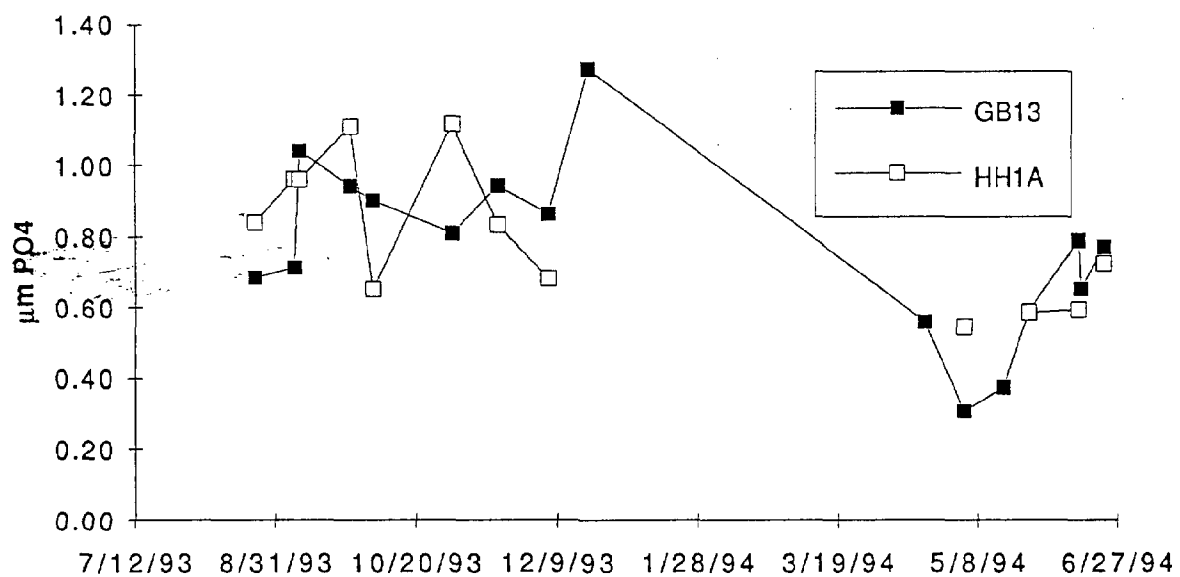
Figure 32. Geometric average fecal coliform concentrations for all data. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
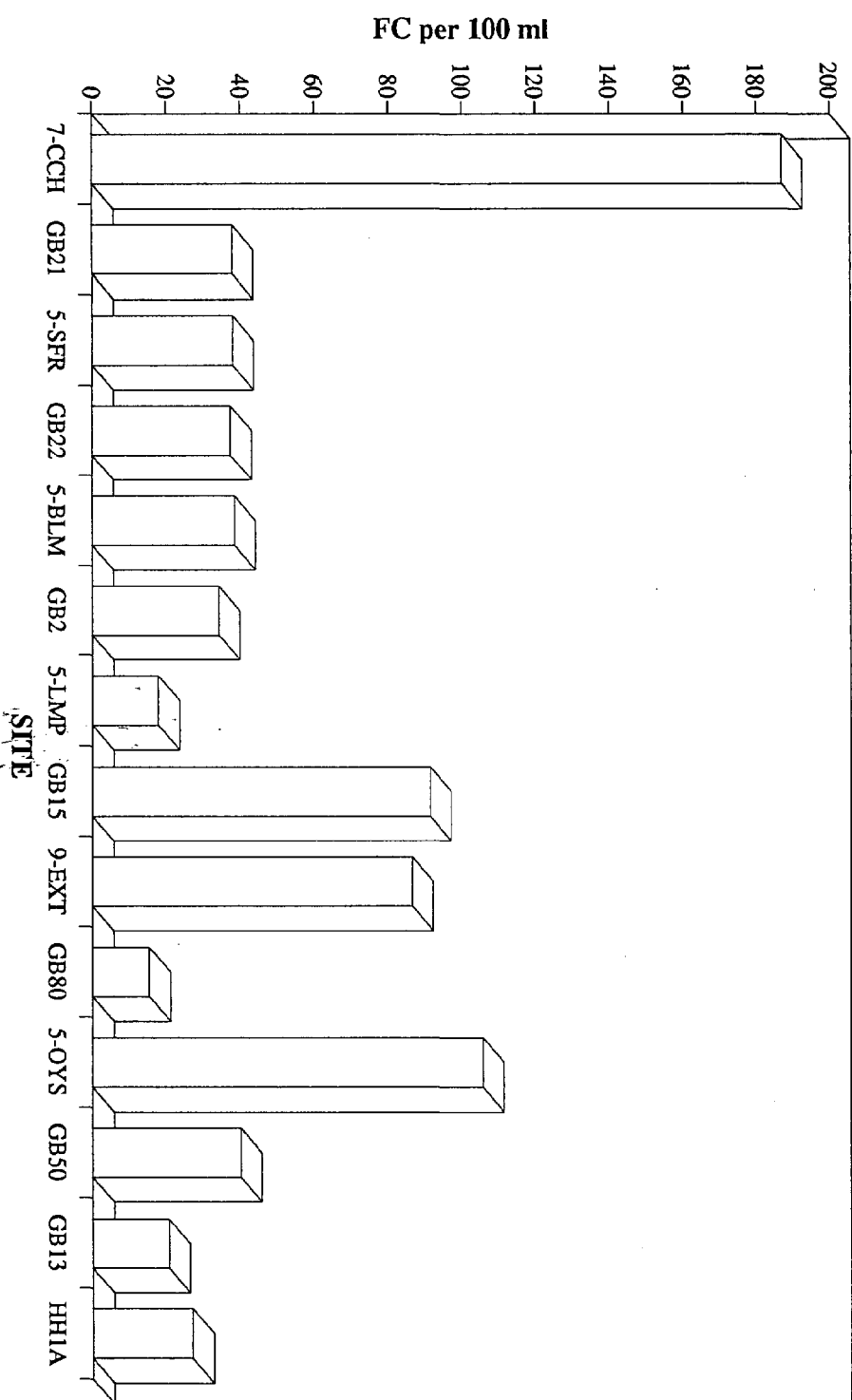
**Figure 32A.** Geometric average fecal coliform concentrations (modified State data) for all data. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).

Ec per 100 ml
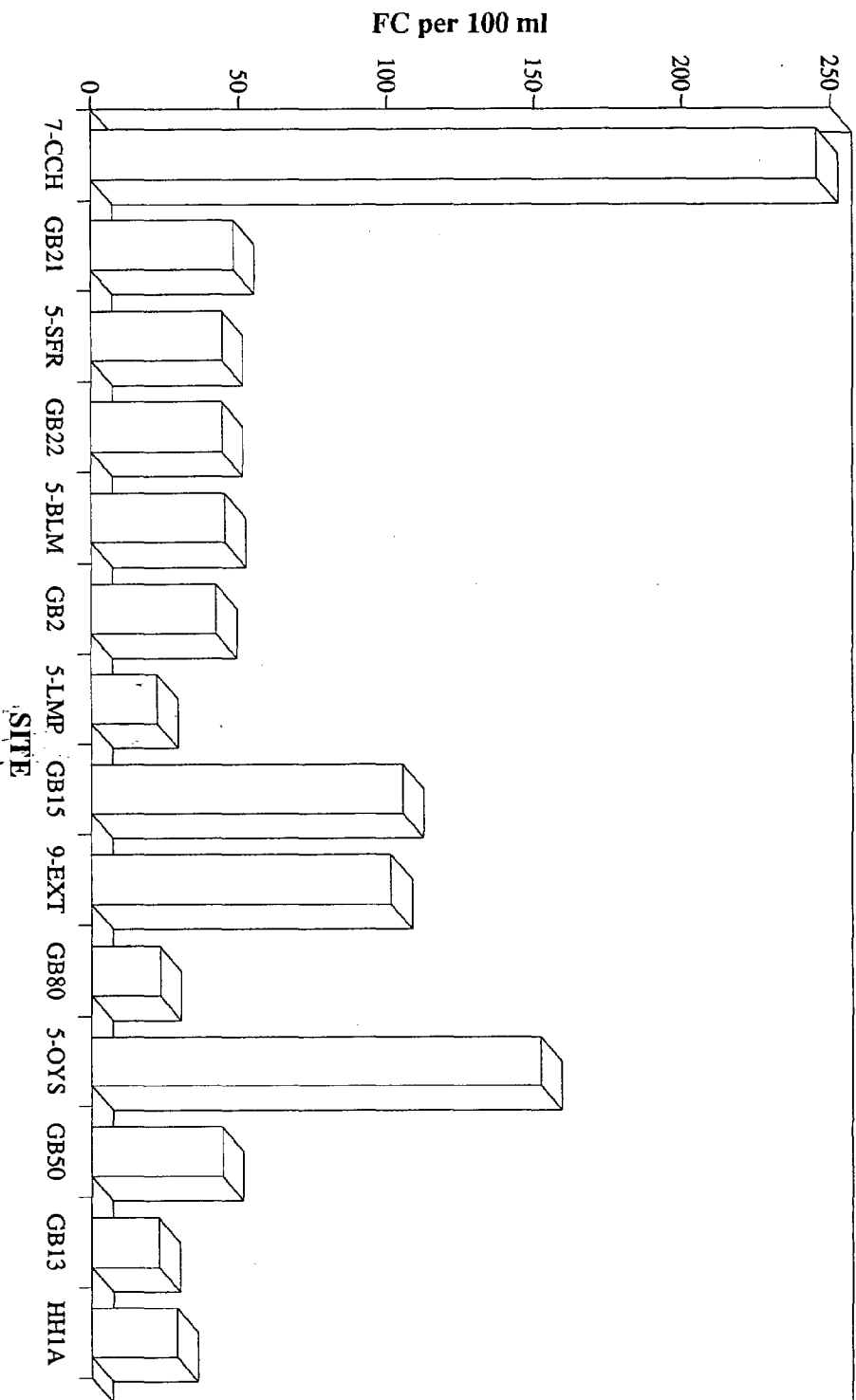
Figure 33. Geometric average E. coli concentrations for all data. Consecutive pairs of sites are
freshwater followed by tidal sites (#-name=fresh; GB#=tidal).

SITE

7-CCH
GB21
5-SFR
GB22
5-BLM
GB2
5-LMP
GB15
9-EXT
GB80
5-OYS
GB50
GB13
HH1A
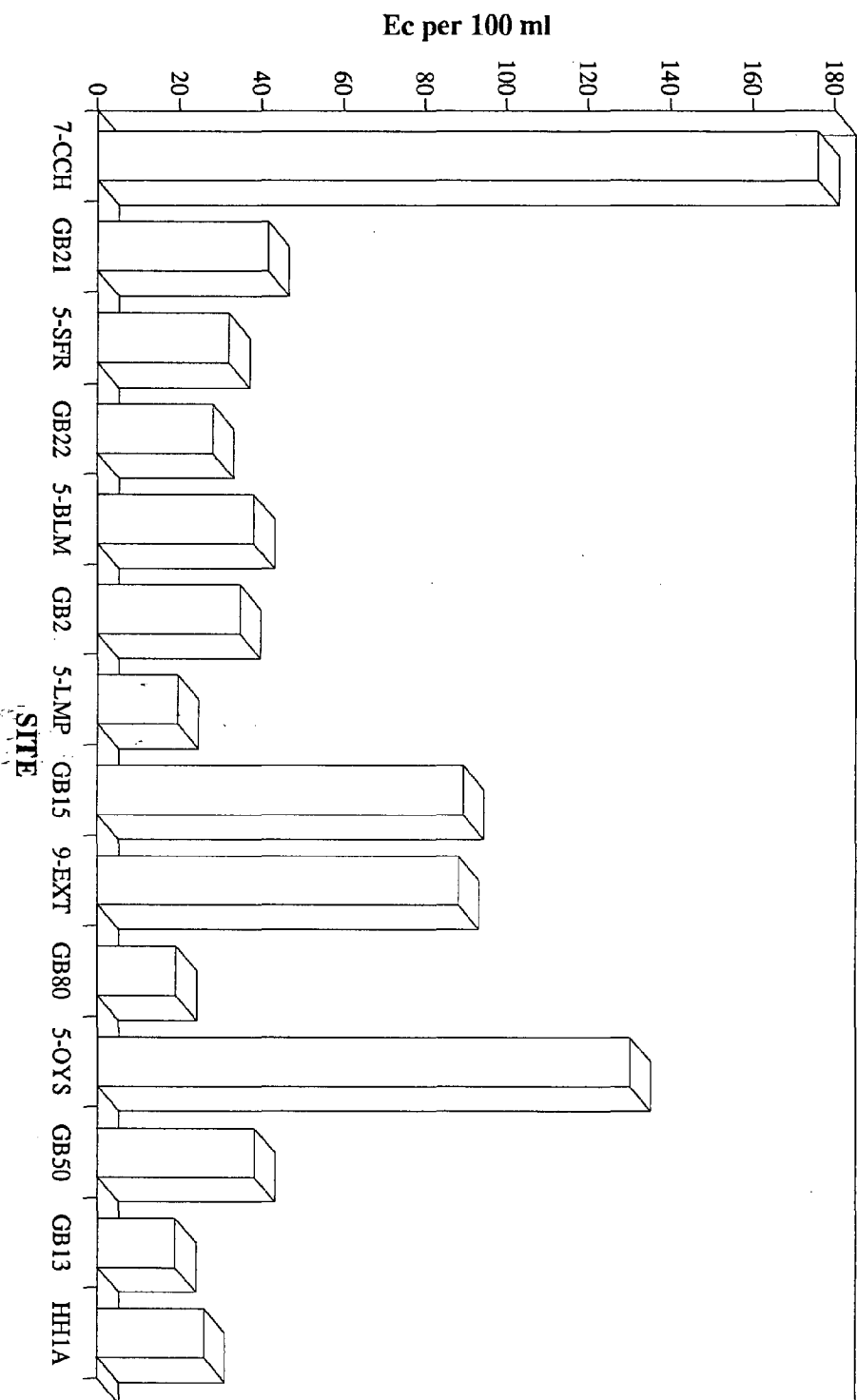
Figure 34. Geometric average enterococci concentrations for all data. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
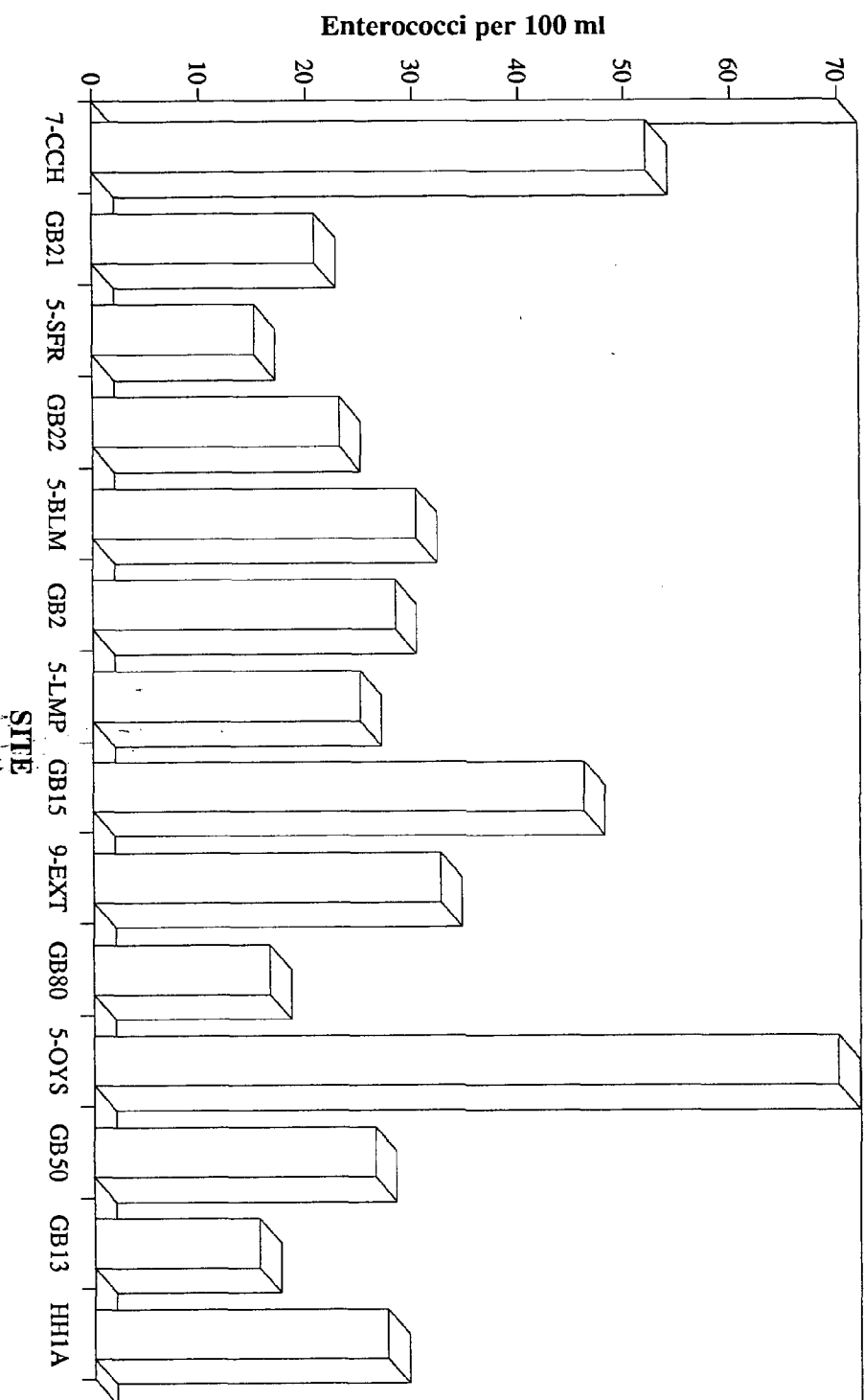
Figure 35. Geometric average fecal coliform concentrations for JEL storm samples. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
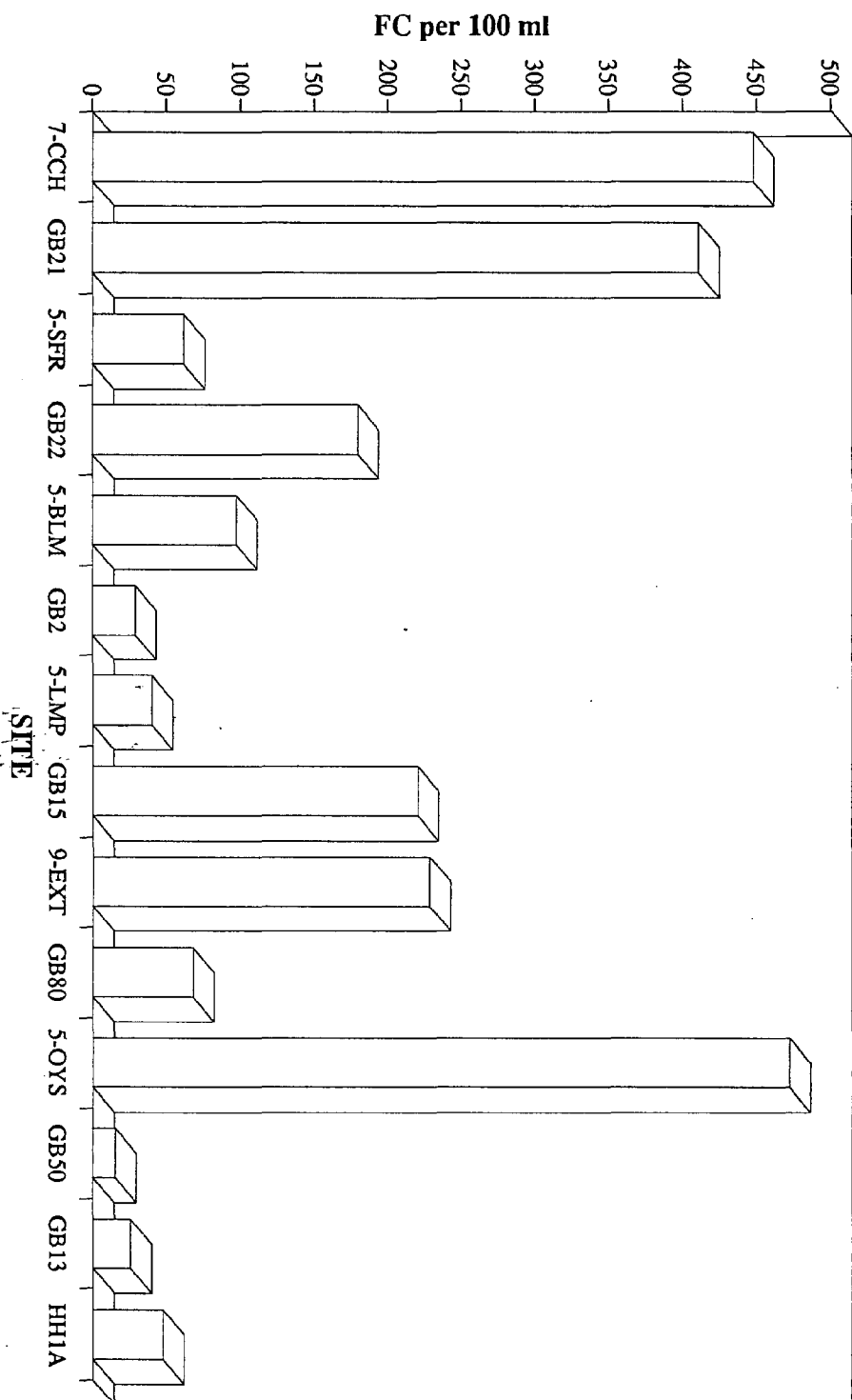
Figure 36. Geometric average E. coli concentrations for JEL storm samples. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
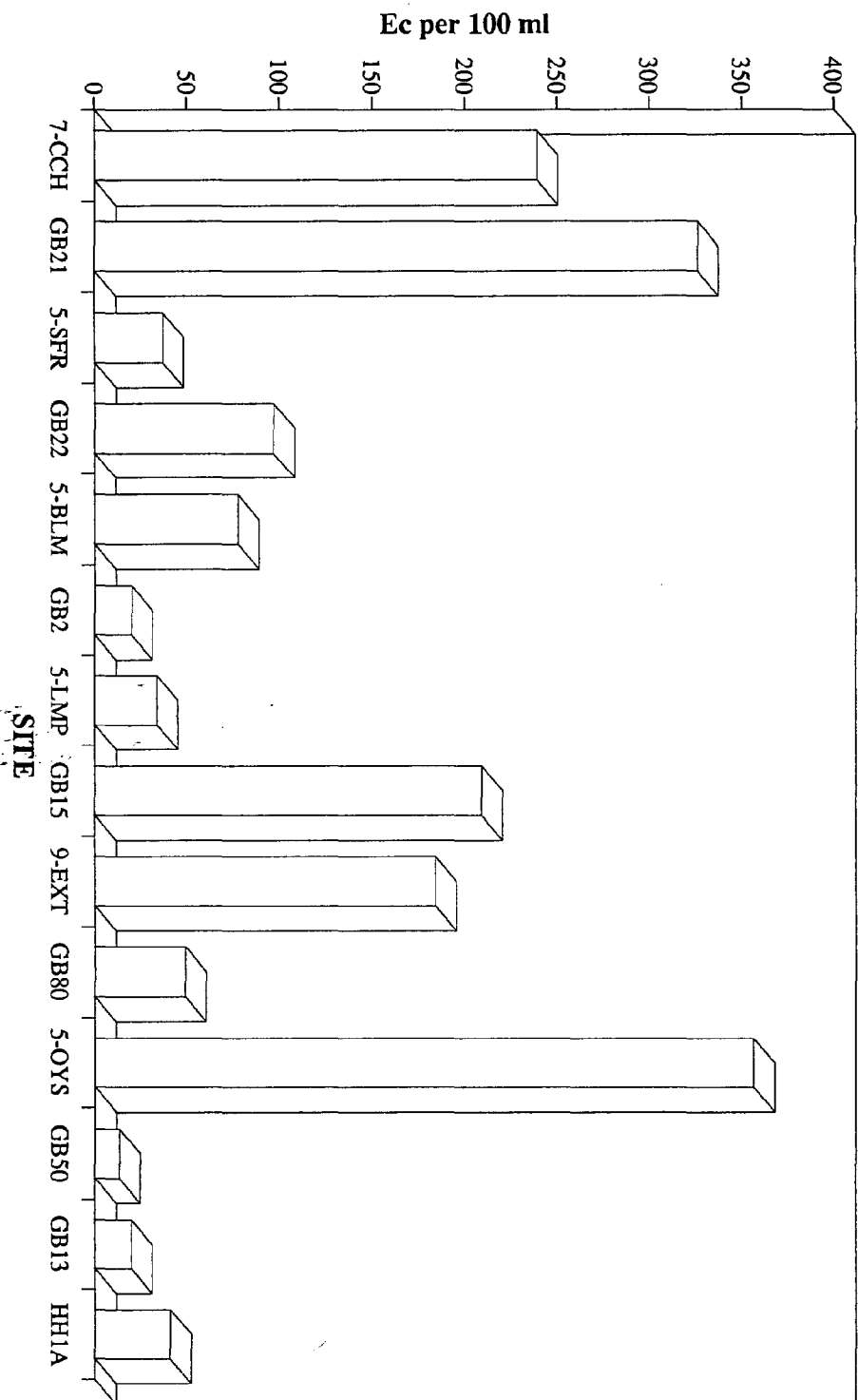
Figure 37. Geometric average enterococci concentrations for JEL storm samples. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
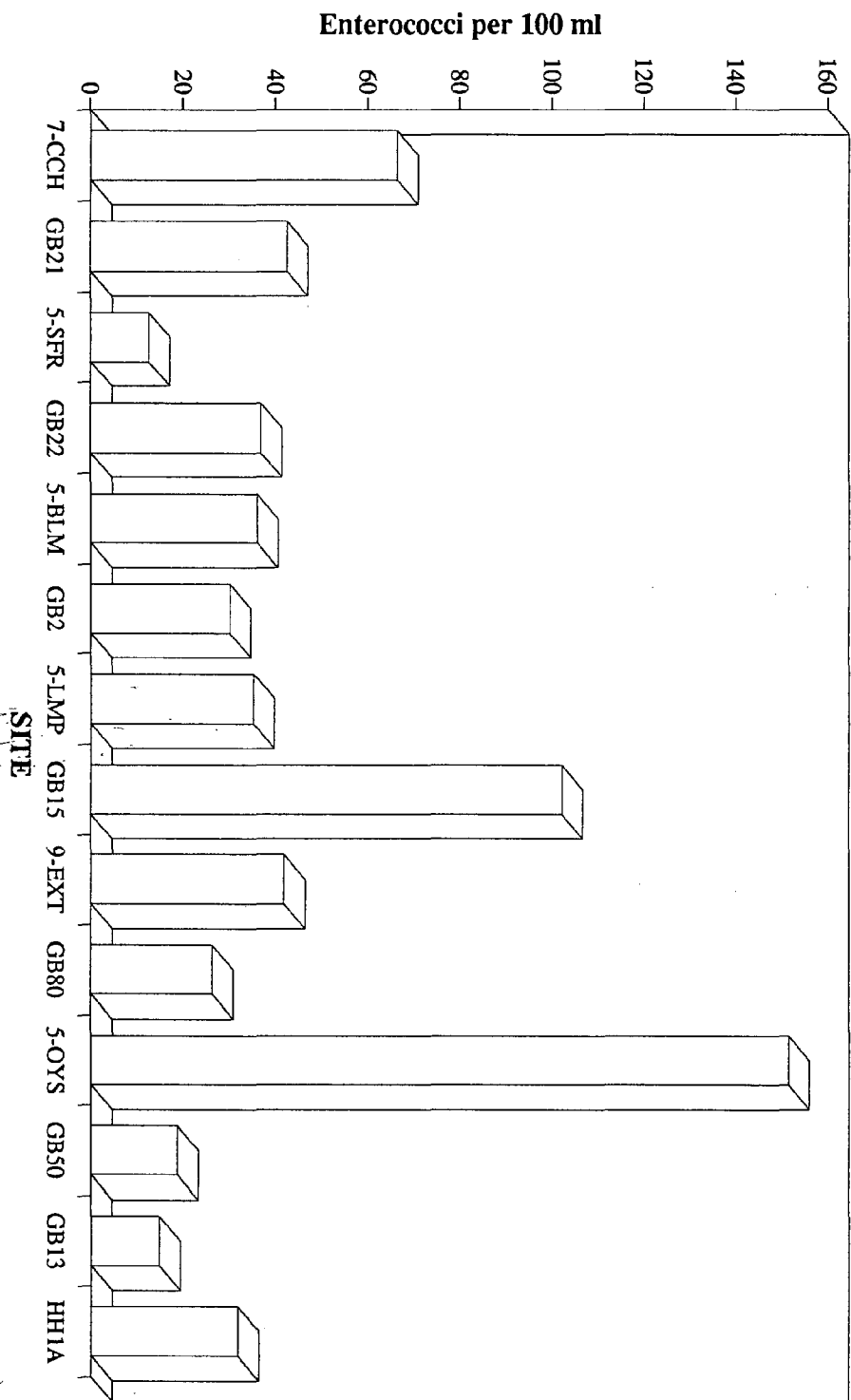
Figure 38. Geometric average fecal coliform concentrations for JEL storm compared to DES random samples. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
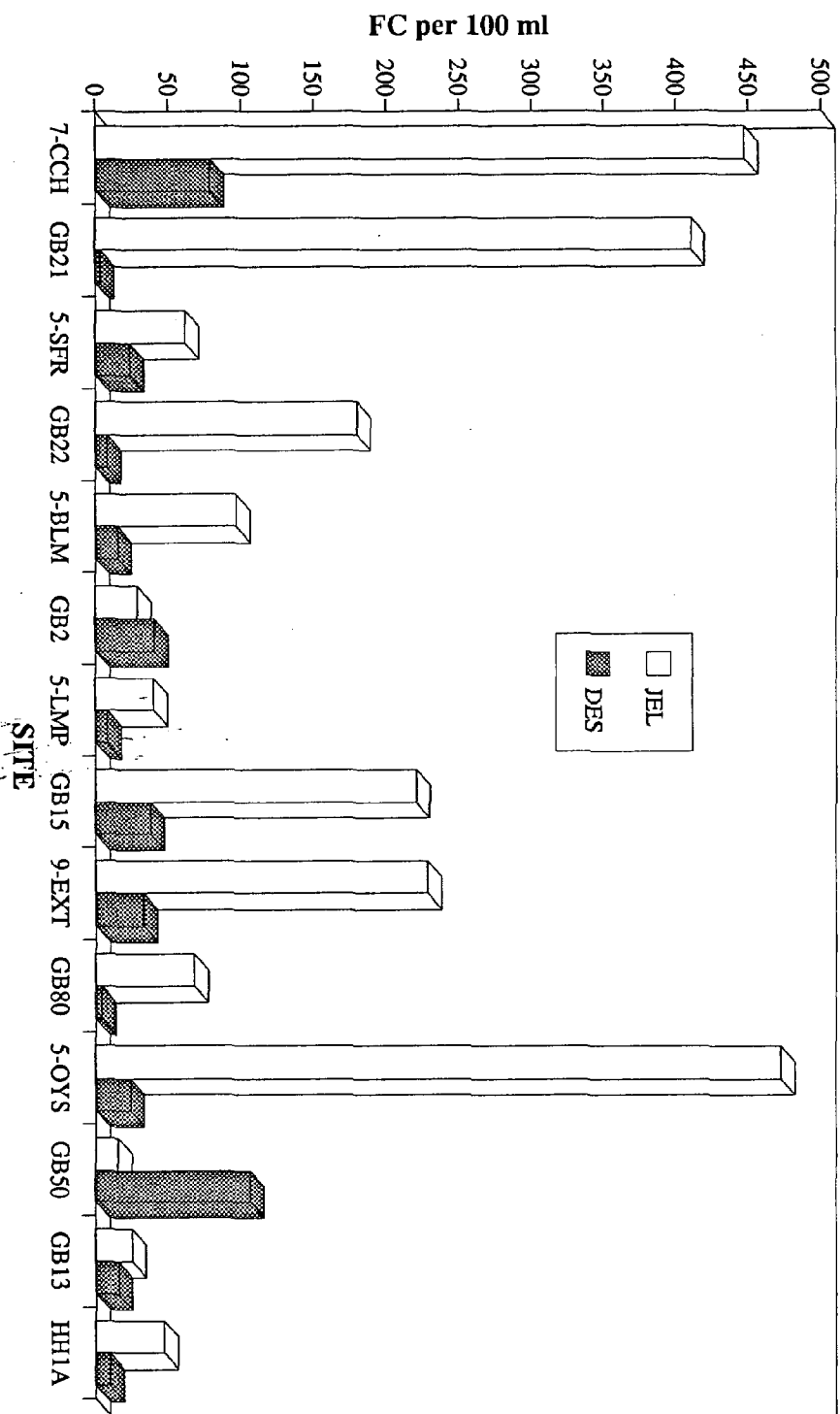
Figure 38A. Geometric average fecal coliform concentrations for JEL storm compared to DES (modified data) random samples. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
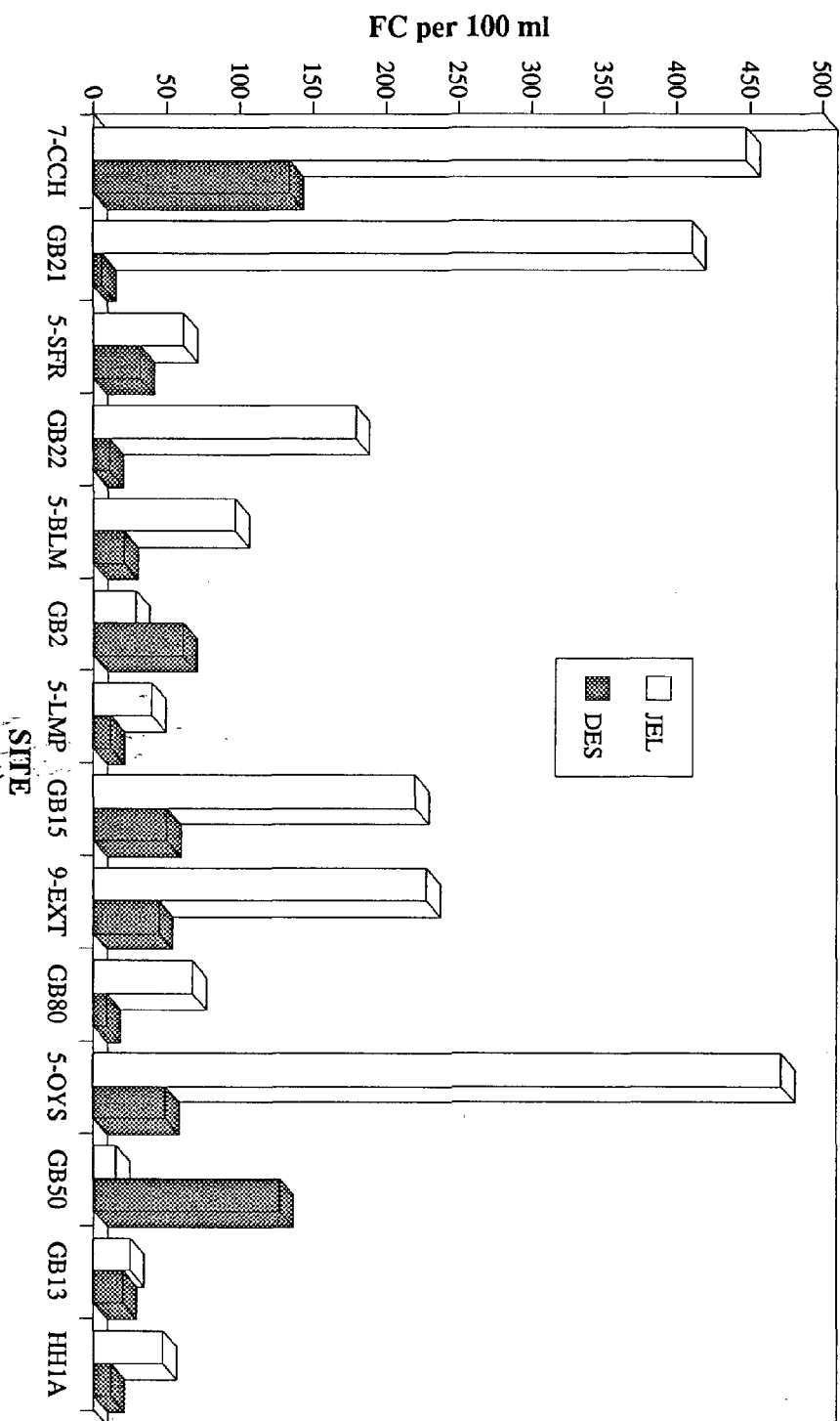
Figure 39. Geometric average E. coli concentrations for JEL storm compared to DES random samples. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
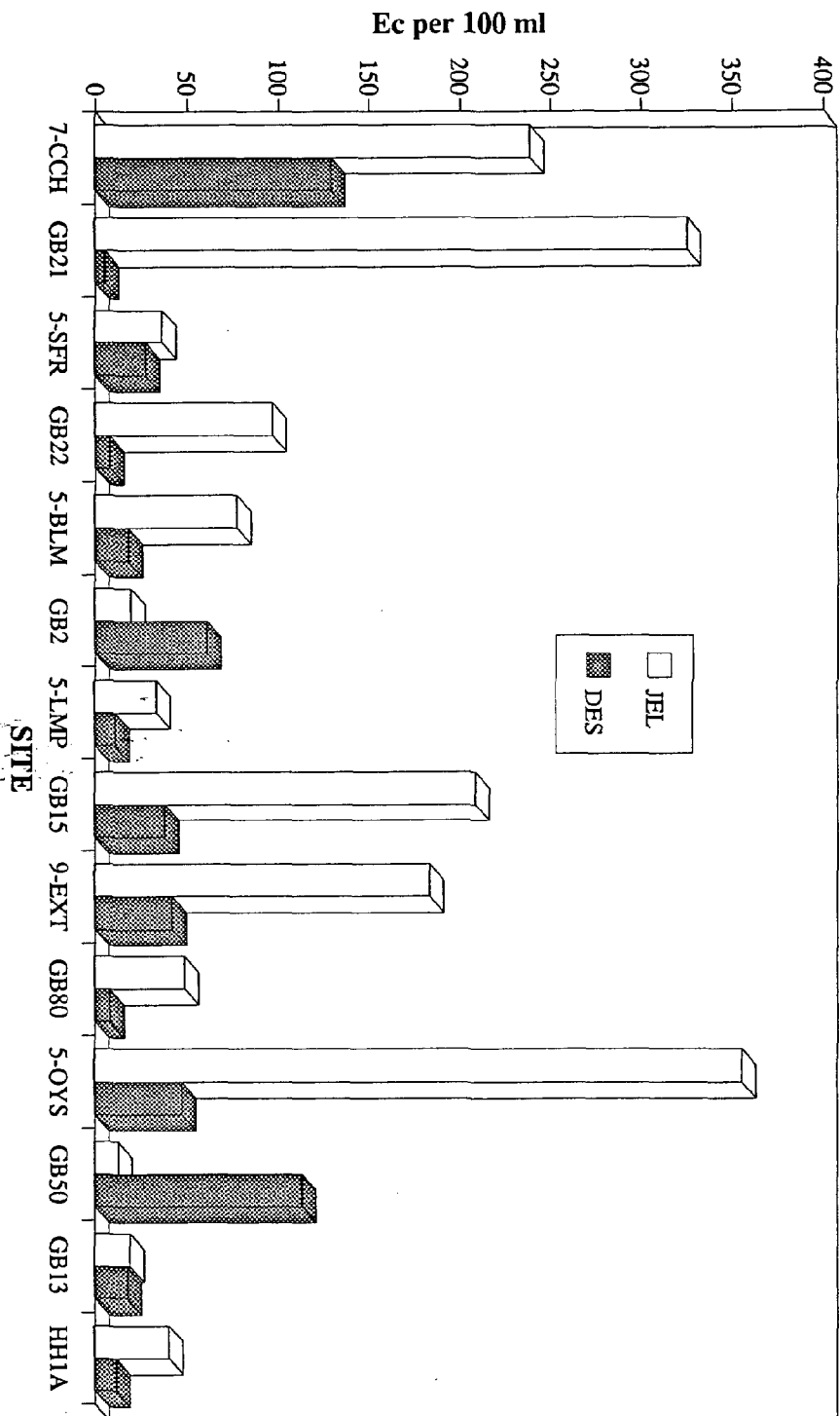
Figure 40. Geometric average enterococci concentrations for JEL storm compared to DES random samples. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
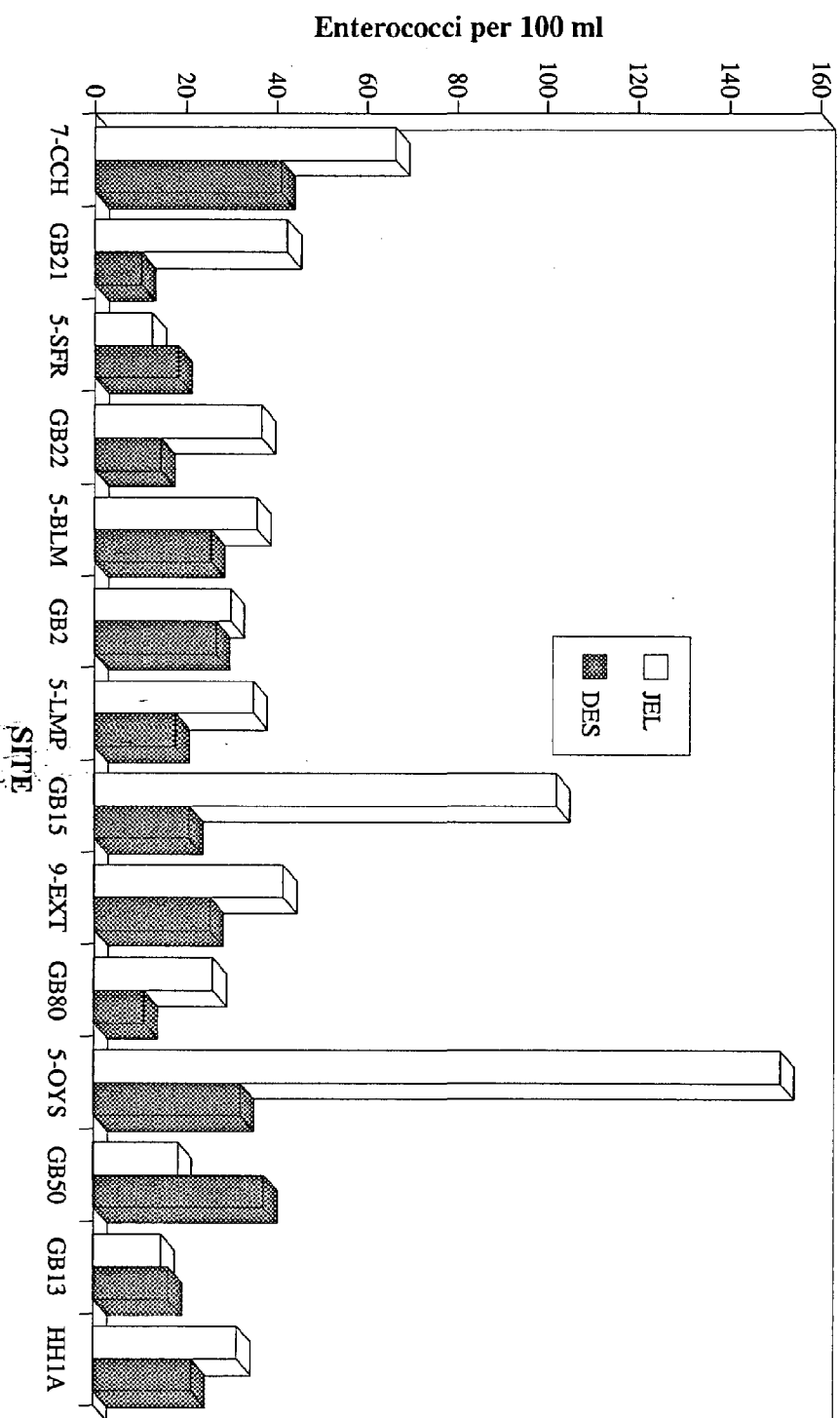
Figure 41. Geometric average fecal coliform concentrations following rainstorms or dry weather. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
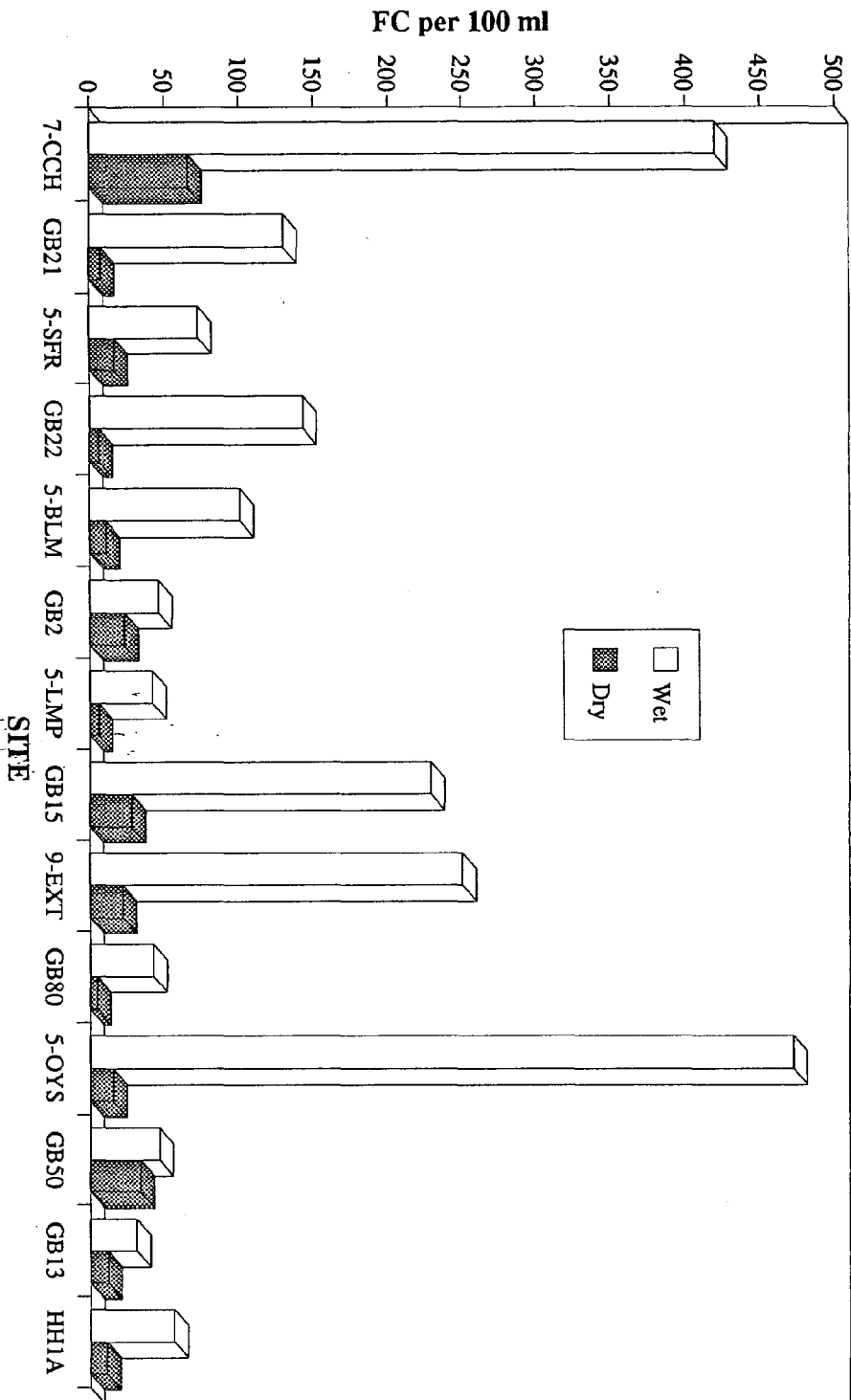
Figure 41A. Geometric average fecal coliform concentrations (modified State data) following rainstorms or dry weather. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
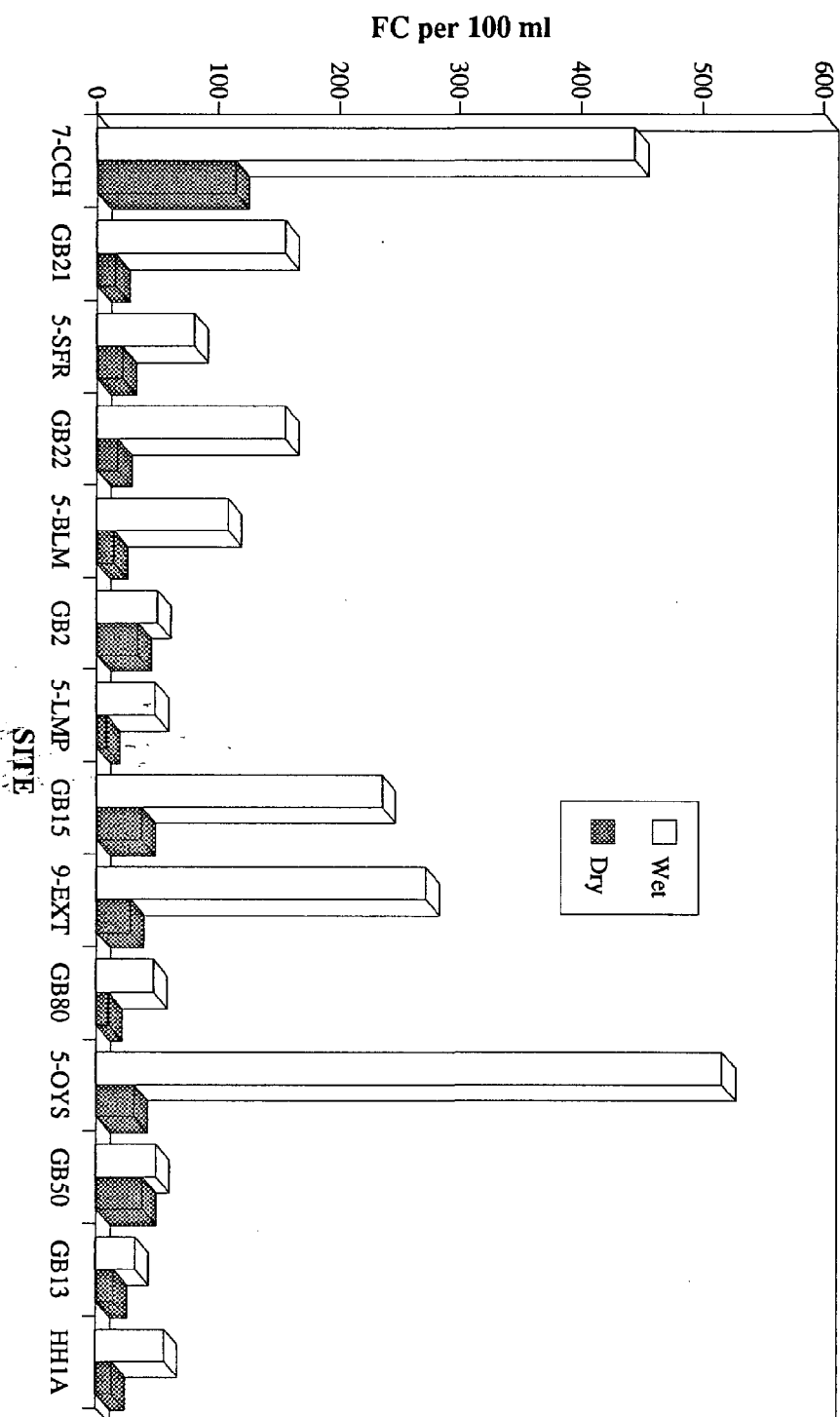
Figure 42. Geometric average E. coli concentrations following rainstorms or dry weather. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
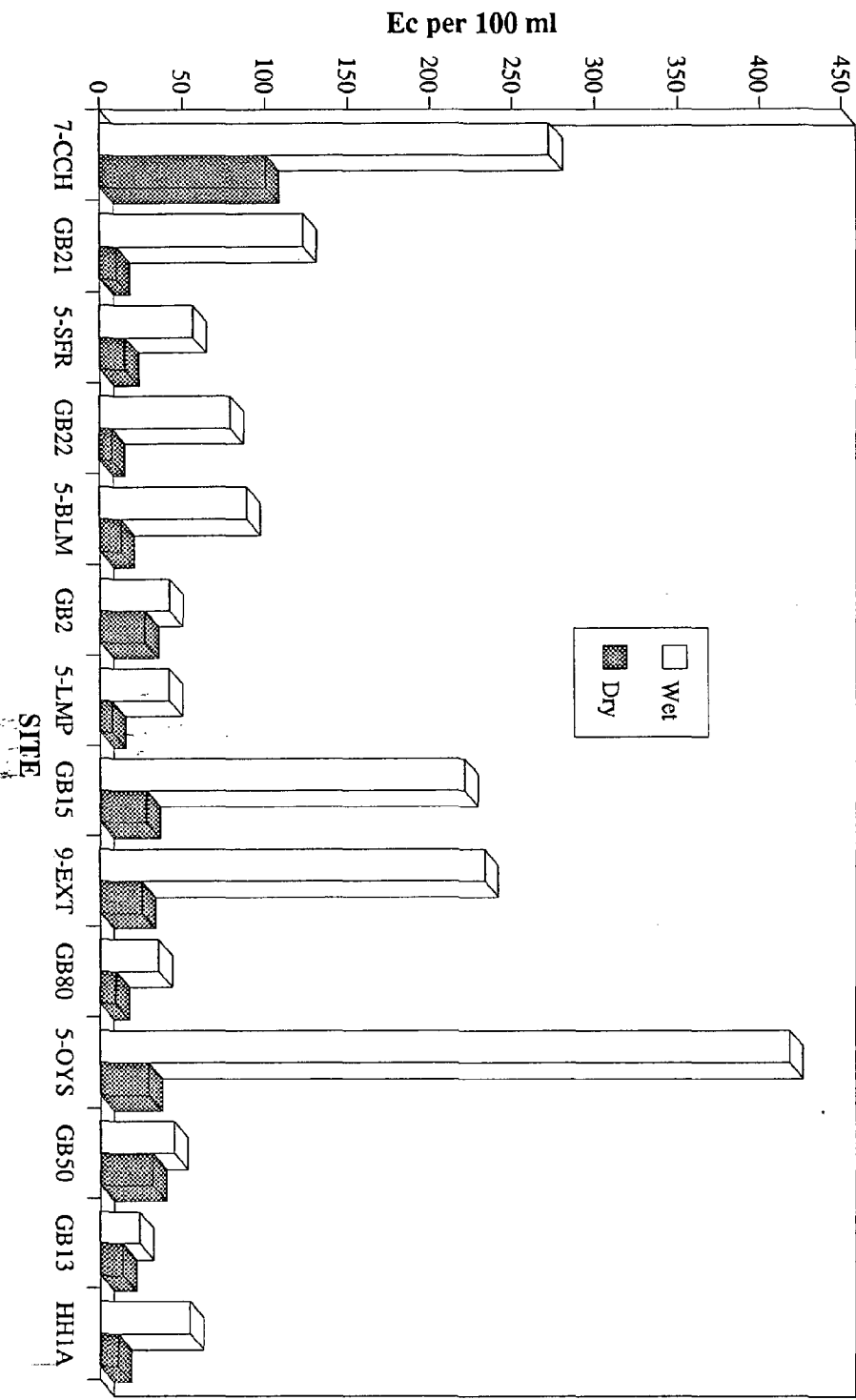
Figure 43. Geometric average enterococci concentrations following rainstorms or dry weather. Consecutive pairs of sites are freshwater followed by tidal sites (#-name=fresh; GB#=tidal).
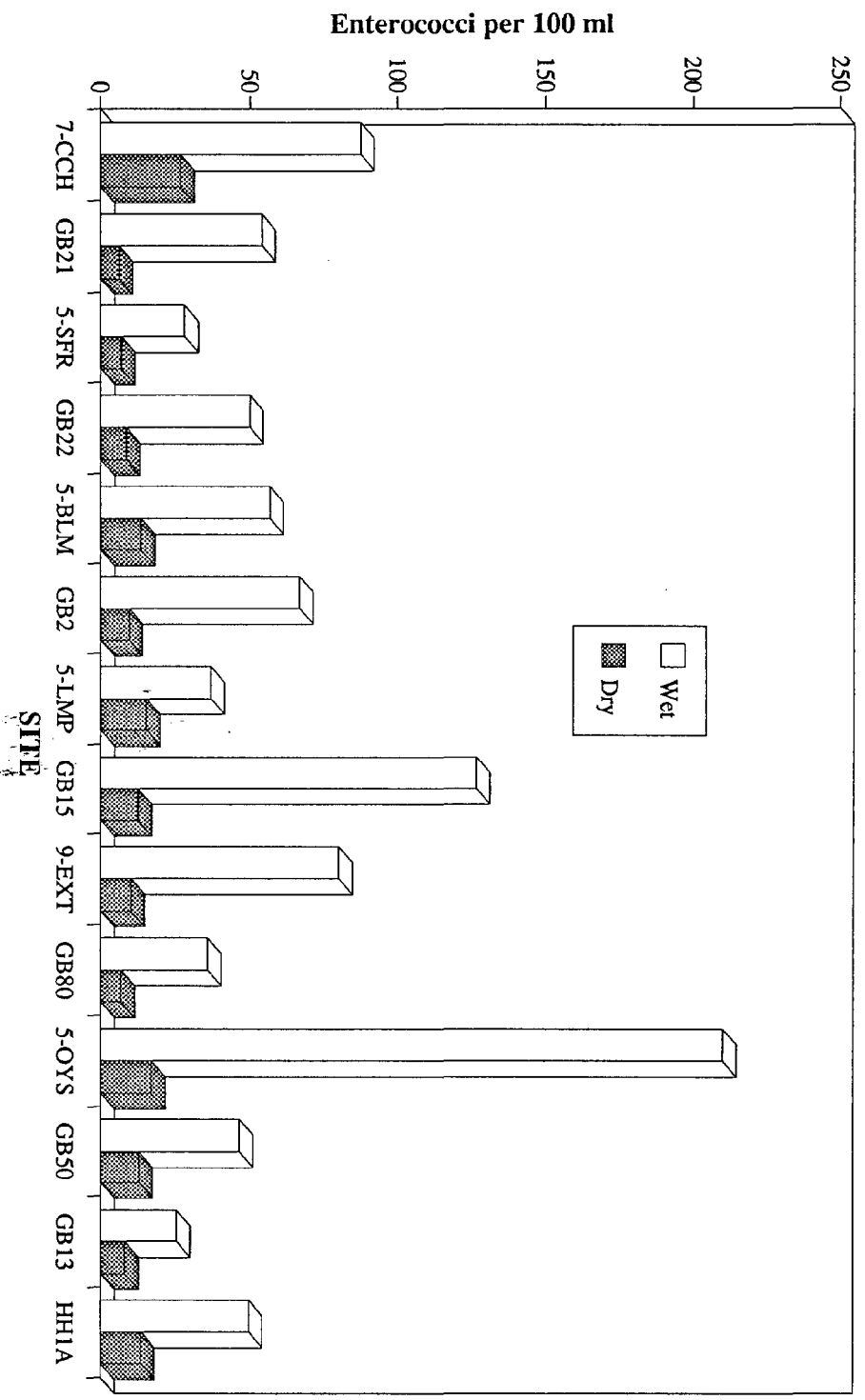
Figure 44. Fecal coliform concentrations at freshwater (closed symbols) and tidal (open symbols) water sites in the Cocheco (7-CCH & GB21) and Salmon Falls (5-SFR & GB22) rivers.
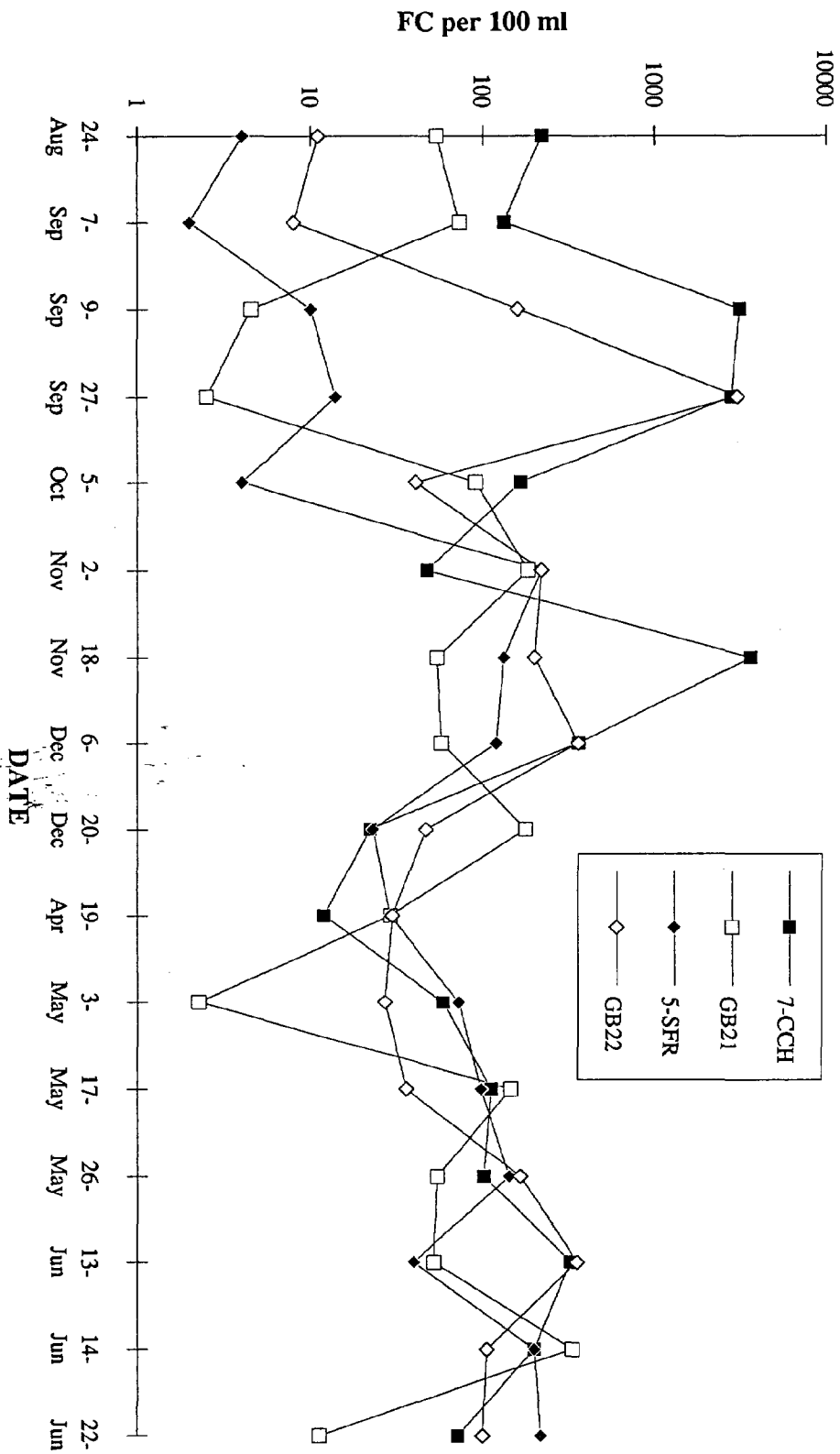
Figure 45. Fecal coliform concentrations at freshwater (closed symbols) and tidal (open symbols) water sites in the Bellamy (7-BLM & GB2) and Lamprey (5-LMP & GB15) rivers.
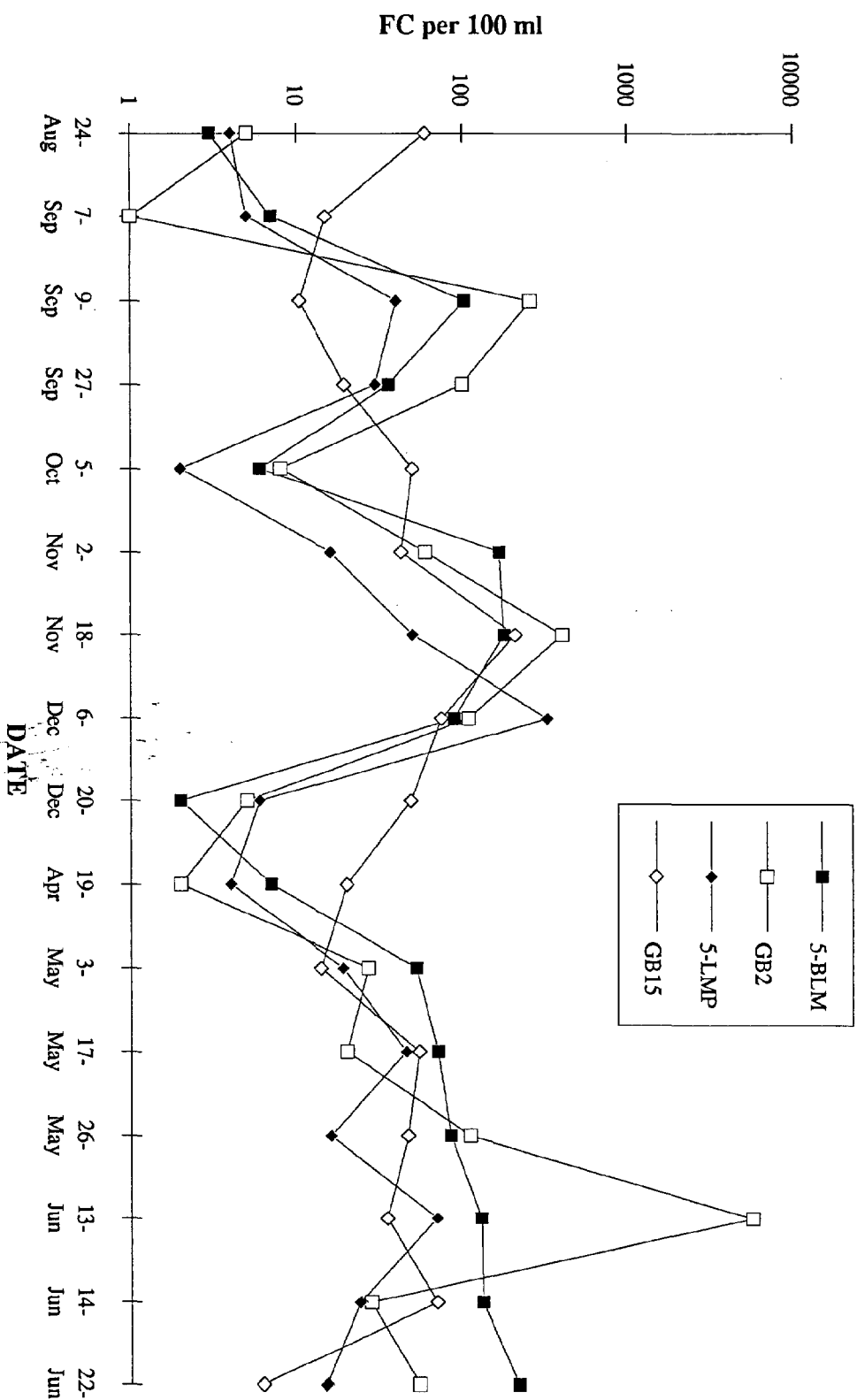
Figure 46. Fecal coliform concentrations at freshwater (closed symbols) and tidal (open symbols) water sites in the Exeter/Squamscott (7-EXT & GB80) and Oyster (5-OYS & GB50) rivers.
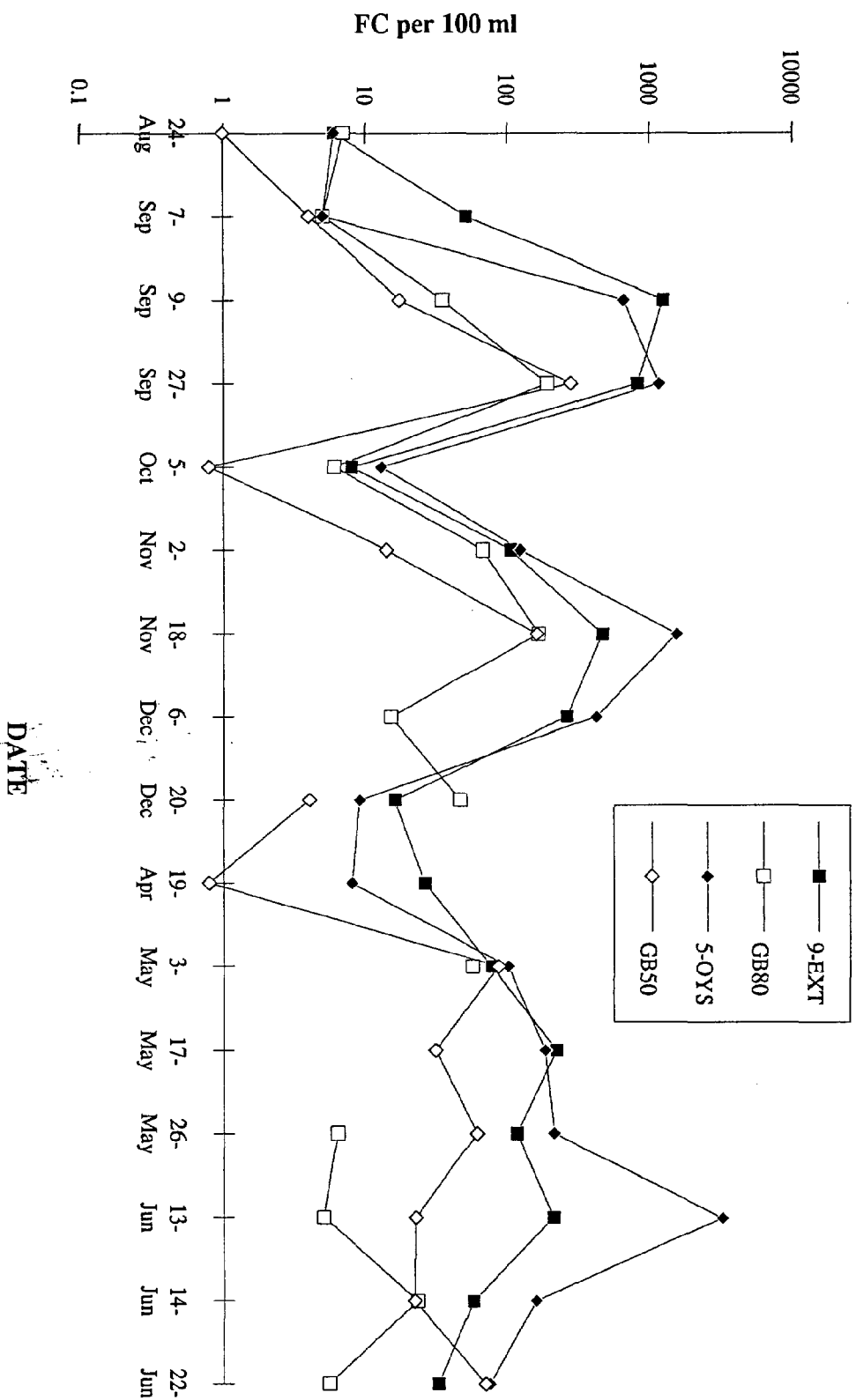
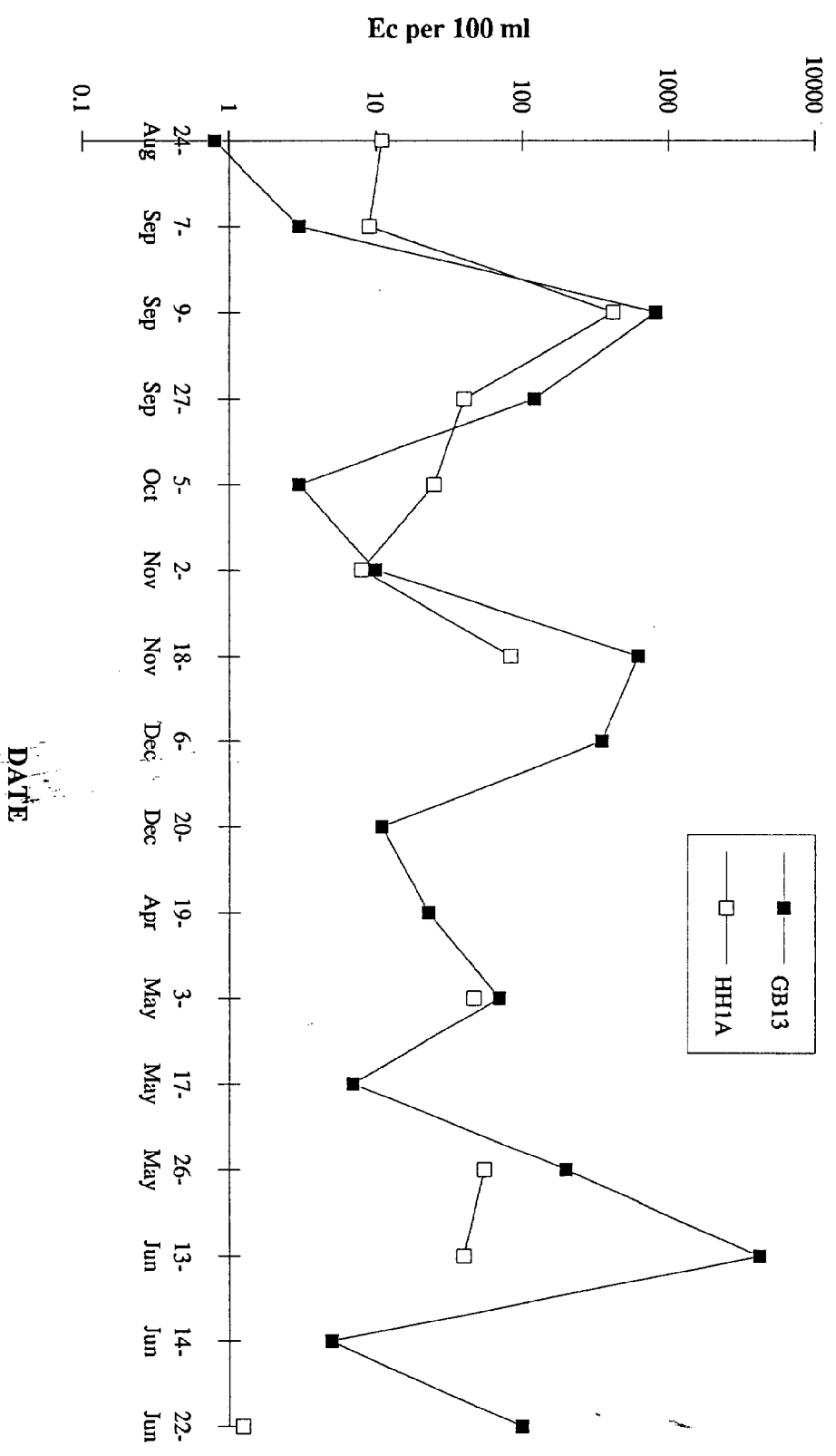**Figure 47. Fecal coliform concentrations at sites in the Piscataqua River (GB13) and Hampton Harbor (HH1A).**
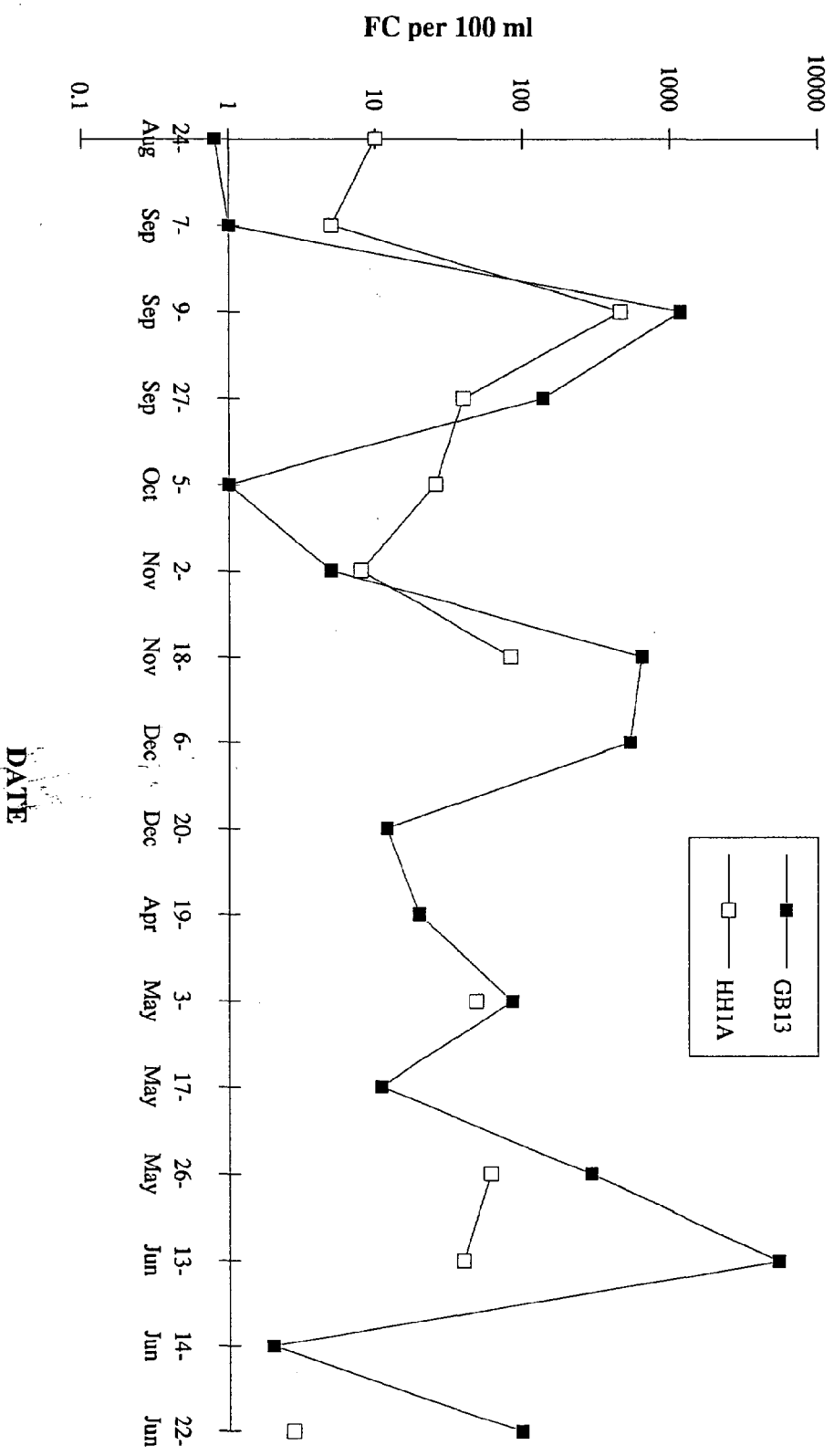
Figure 48. E. coli concentrations at freshwater (closed symbols) and tidal (open symbols) water sites in the Cocheco (7-CCH & GB21) and Salmon Falls (5-SFR & GB22) rivers.
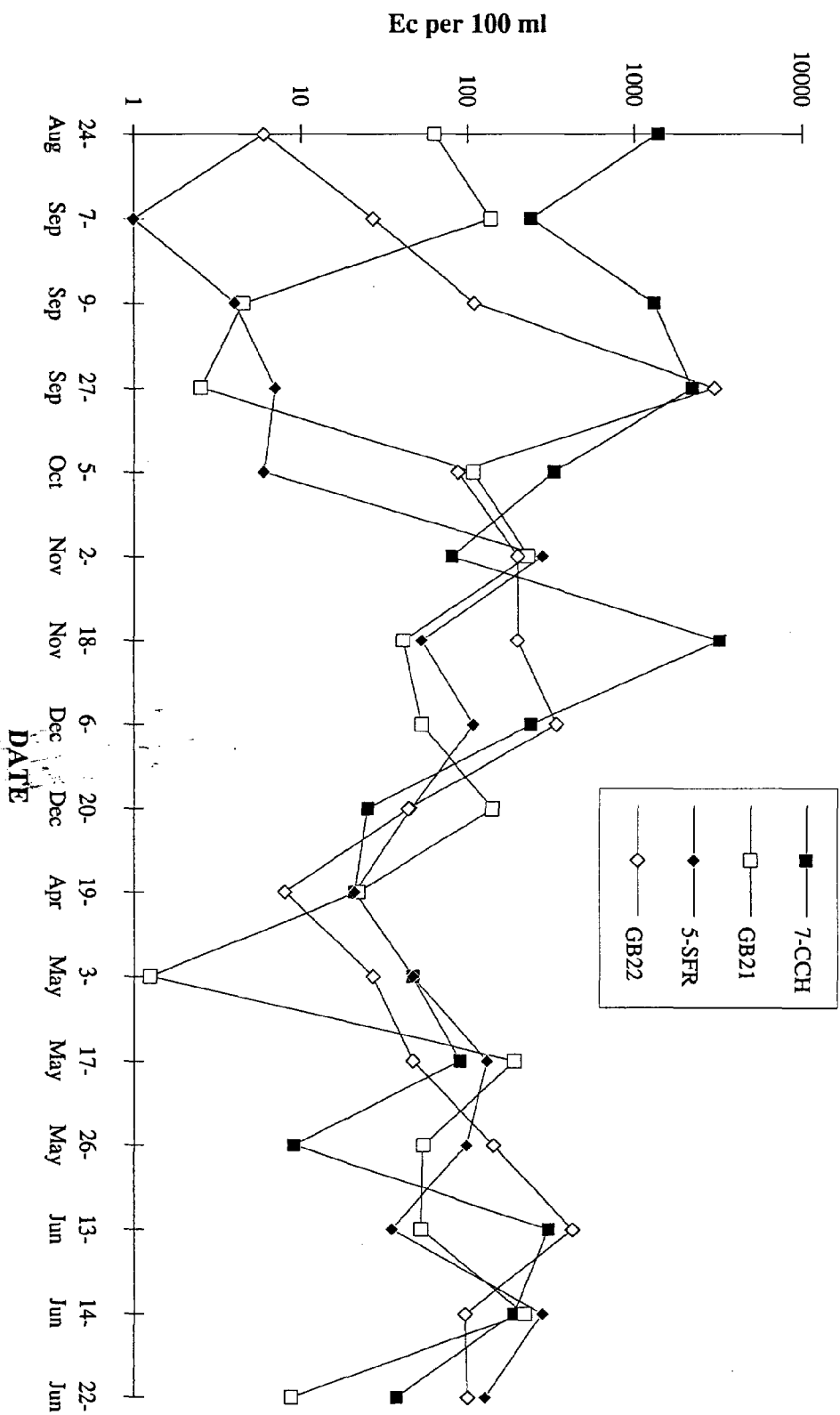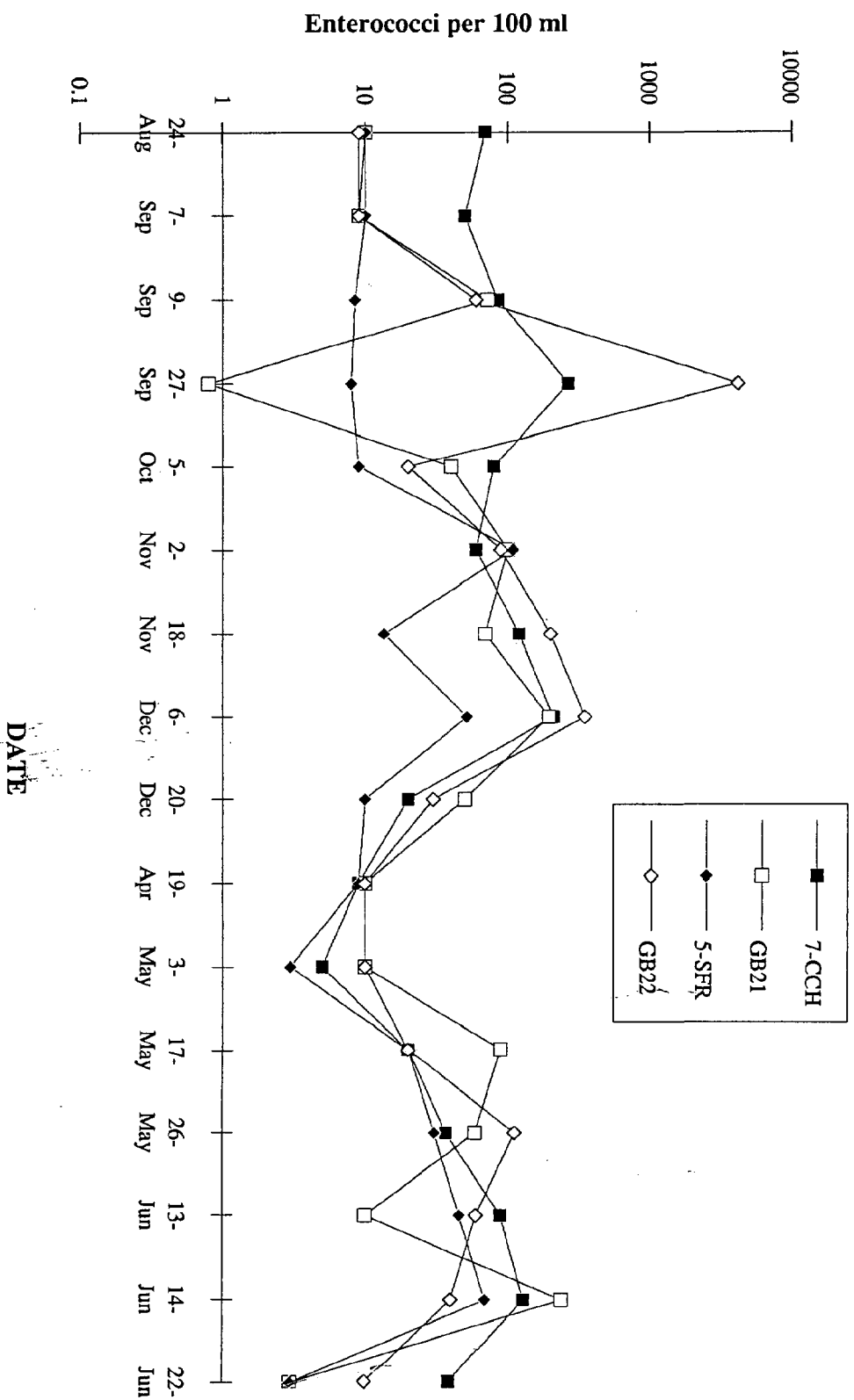
Figure 49. E. coli concentrations at freshwater (closed symbols) and tidal (open symbols) water sites in the Bellamy (7-BLM & GB2) and Lamprey (5-LMP & GB15) rivers.
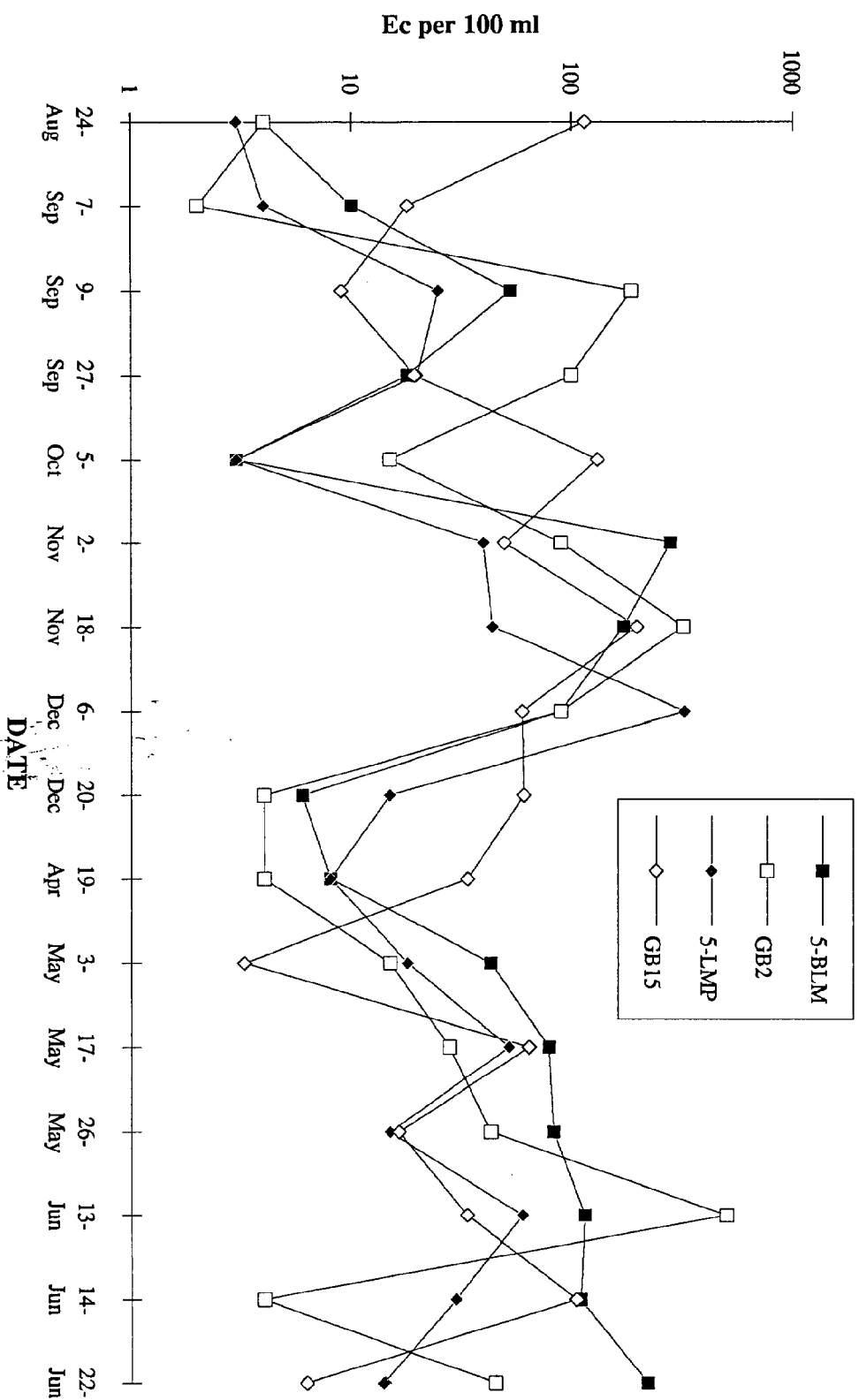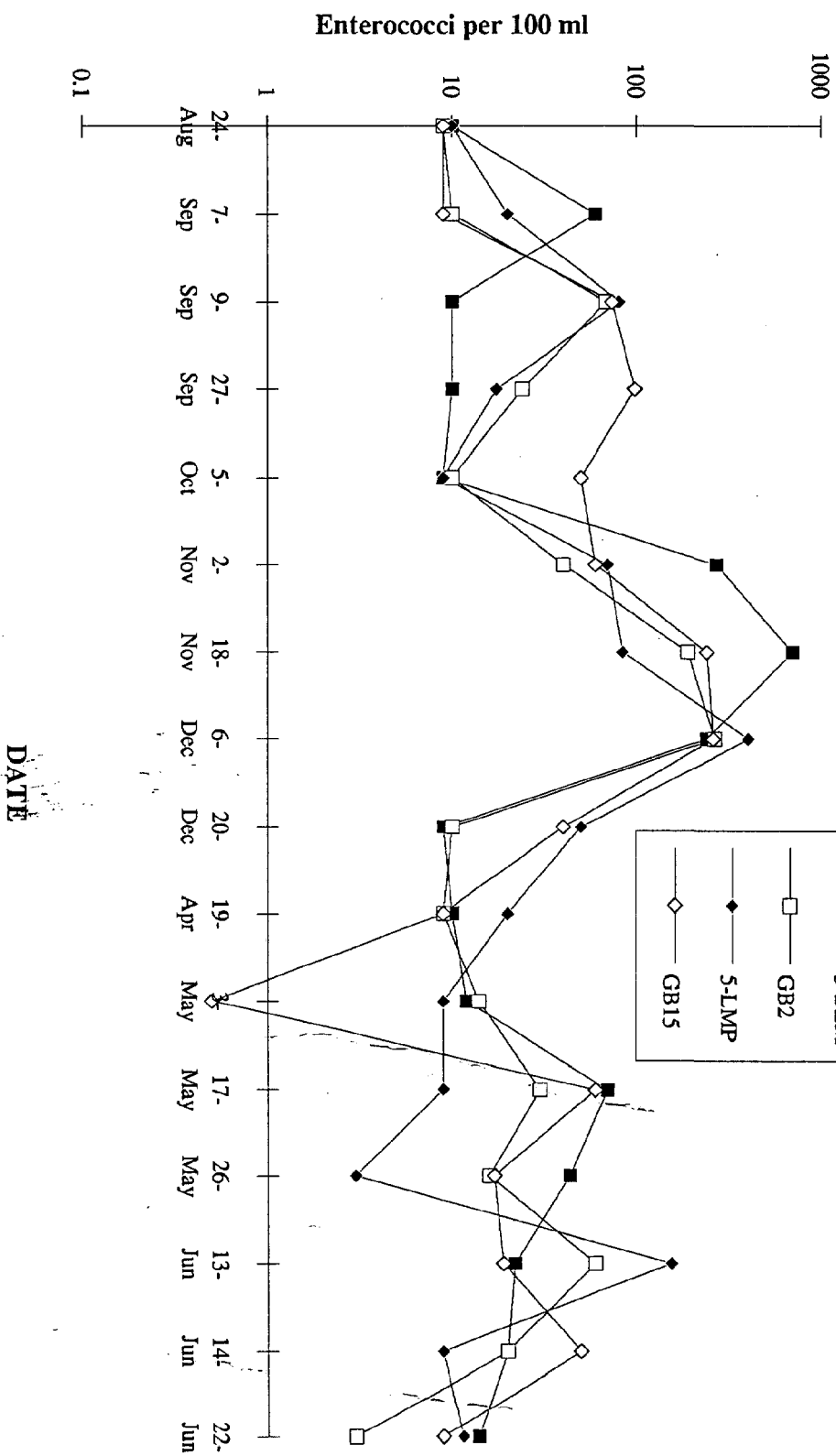
Figure 50. E. coli concentrations at freshwater (closed symbols) and tidal (open symbols) water sites in the Exeter/Squamscott (7-EXT & GB80) and Oyster (5-OYS & GB50) rivers.

Ec per 100 ml
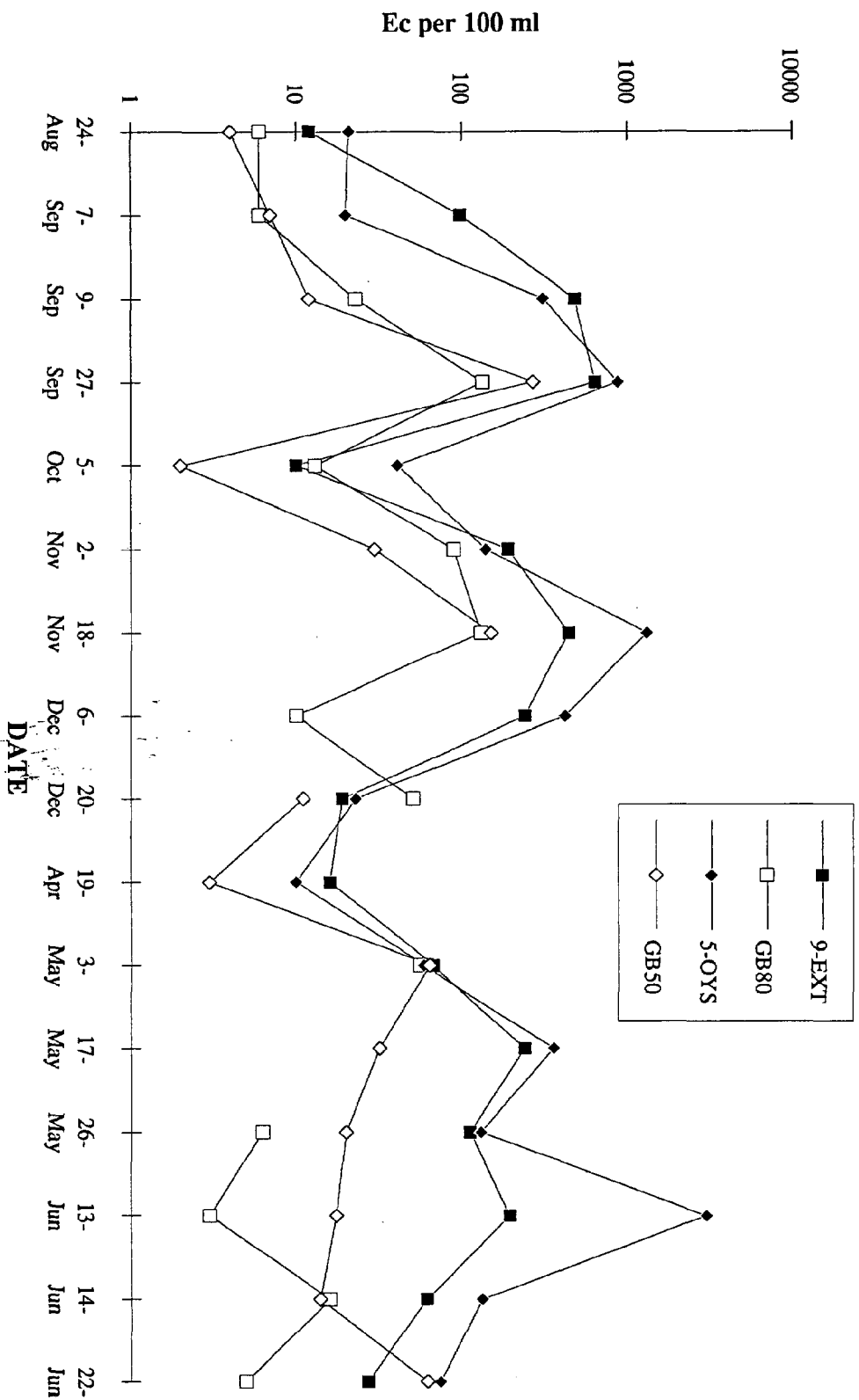
Figure 51. E. coli concentrations at sites in the Piscataqua River (GB13) and Hampton Harbor (HH1A).

DATE

GB13
HH1A

Figure 52. Enterococci concentrations at freshwater (closed symbols) and tidal (open symbols) water sites in the Cocheco (7-CCH & GB21) and Salmon Falls (5-SFR & GB22) rivers.

Figure 53. Enterococci concentrations at freshwater (closed symbols) and tidal (open symbols) water sites in the Bellamy (7-BLM & GB2) and Lamprey (5-LMP & GB15) rivers.

Figure 54. Enterococci concentrations at freshwater (closed symbols) and tidal (open symbols) water sites in the Exeter/Squamscott (7-EXT & GB80) and Oyster (5-OYS & GB50) rivers.
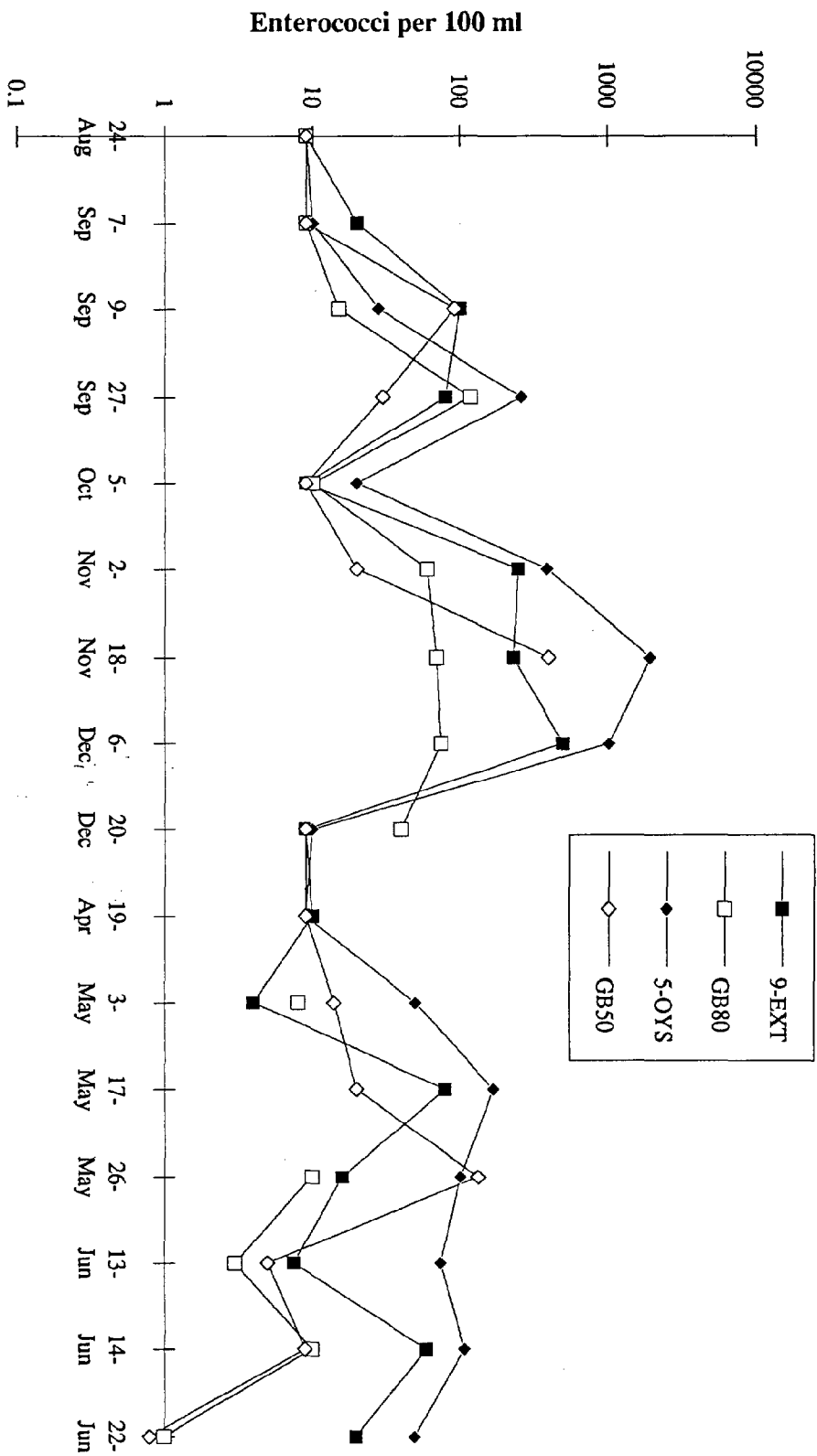
Figure 55. Enterococci concentrations at sites in the Piscataqua River (GB13) and Hampton Harbor (HH1A).